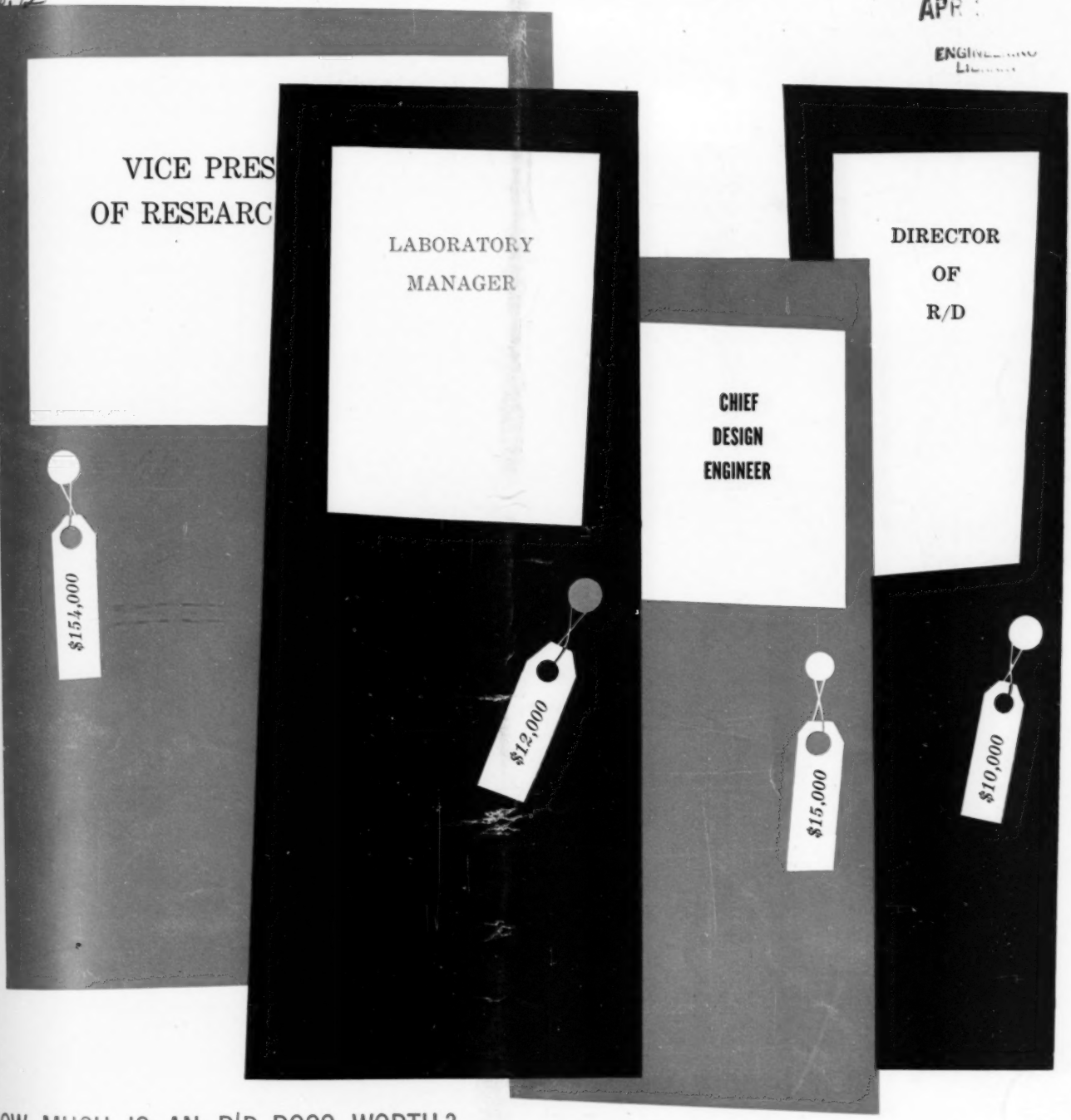
ER 1956

Research & Engineering

for MANAGERS of research design and development

R/E



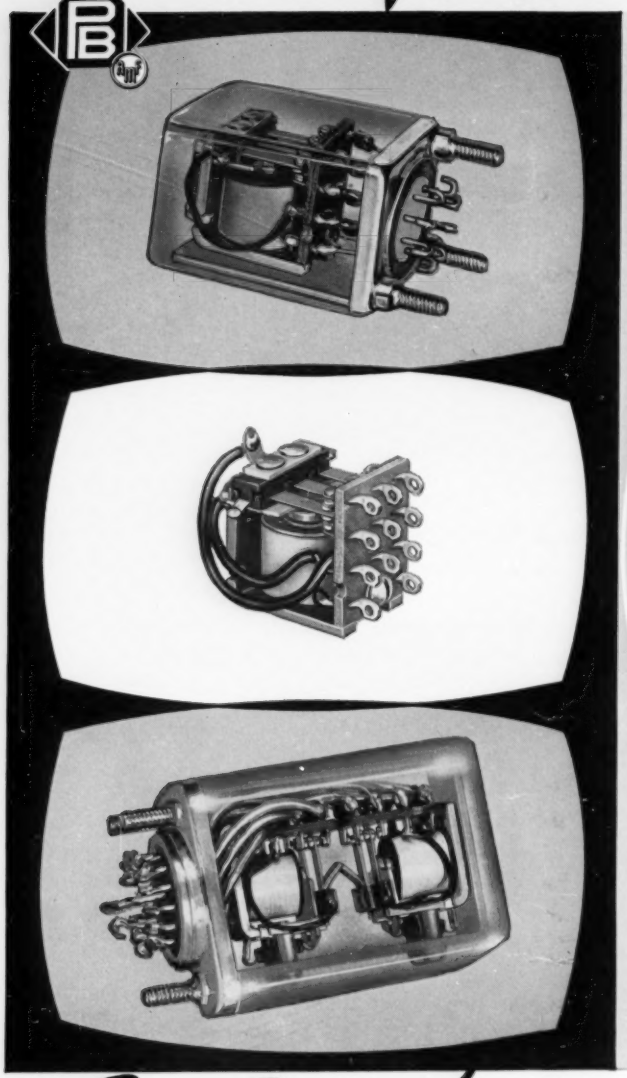
HOW MUCH IS AN R/D BOSS WORTH?

SO YOU'RE GOING TO MAKE A SPEECH

THIS IS INERTIAL NAVIGATION

FACE TO FACE: R/E INTERVIEWS HUTCHESON OF WESTINGHOUSE

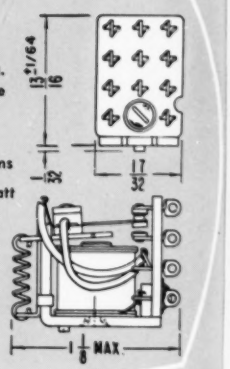
Potter & Brumfield PRESENTS AN IMPORTANT NEW RELAY SERIES



A three-pole, hermetically sealed version of the KM provides a multiplicity of action yet requires a minimum of space. Mounted with three #6-32 studs; eight solder terminals. This relay is especially useful in low voltage, DC applications where size and weight are critical factors.

ENGINEERING DATA
KM SERIES

CONTACTS: Max. 3PDT. 3/32" Dia. Silver 2 amps, 115V 60 cy. resistive
VOLTAGE RANGE: Up to 48V DC nominal
COIL RESISTANCE: Up to 6700 ohms
COIL POWER REQUIREMENT: 1 watt
TEMP RANGE: −45° C to +55° C
PULL-IN: 75% of nominal voltage
TERMINALS: Solder lugs



Designated as the KE, this latching relay combines two KMs for minimum size and weight. It operates on momentary impulse to either coil with a mechanical latch and electric release. Available up to 6 PDT. This relay was designed for intermittent duty only. Three-stud mounted with solder terminals. Hermetically sealed model is shown at left. Also availabie in open version.

Good Relay News! KM SERIES ANSWERS DESIGN NEEDS

Designers plagued with problems of miniaturization welcome the KM series as good relay news. These subminiature relays—open, hermetically sealed and latching—are wonderfully versatile, light in weight, and amazingly compact. The open KM occupies less than a cubic inch of space! Application possibilities range over such diverse fields as remote control systems, automated toys, small business machines and alarm systems. New applications suggest themselves daily to engineers working with designs where component size and weight must be kept to barest minimums. Your inquiries about our KM series relays are invited!

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PRINCETON, INDIANA

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FOR MORE INFORMATION CIRCLE 1 ON PAGE 48

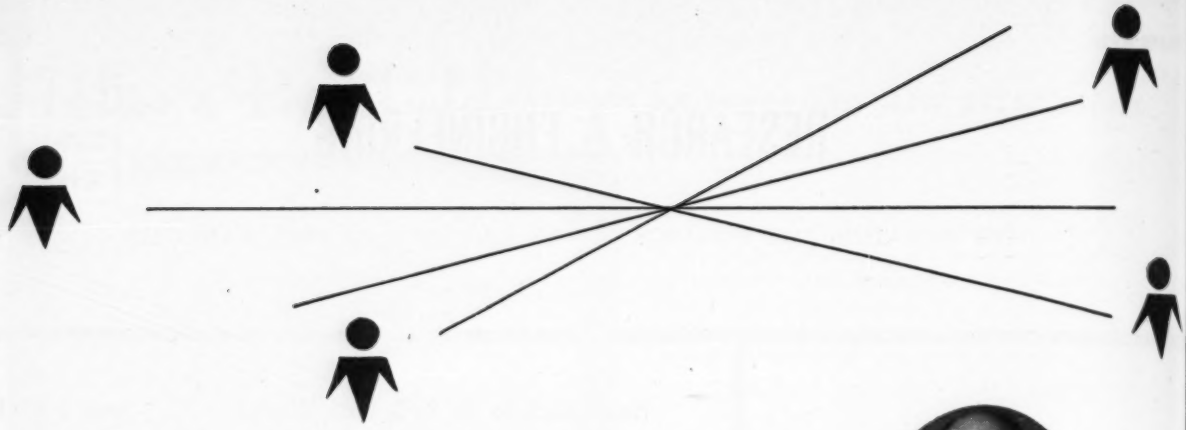
ECEMBER 1956
l. 2, No. 12

RESEARCH & ENGINEERING

THE MAGAZINE FOR RESEARCH DESIGN AND DEVELOPMENT MANAGERS

R/E

RESEARCH & ENGINEERING IS CIRCULATED TO MEN IN CHARGE OF INDUSTRIAL RESEARCH, DEVELOPMENT AND DESIGN DEPARTMENTS IN ALL BRANCHES OF INDUSTRY AND IN GOVERNMENT RESEARCH INSTALLATIONS. SUBSCRIPTION, U. S. A. AND CANADA, $10.00 ANNUALLY; OTHER COUNTRIES, $20.00 ANNUALLY; SINGLE ISSUE, $1.00 WHEN AVAILABLE. PUBLISHED MONTHLY BY THE RELYEA PUBLISHING CORPORATION, WILLIAM H. RELYEA, JR., PRESIDENT; EXECUTIVE, ADVERTISING AND SUBSCRIPTION OFFICE: 103 PARK AVE., NEW YORK 17, N.Y. LE 2-0541. EDITORIAL OFFICE: 77 SOUTH STREET, STAMFORD, CONN., FIRESIDE 9-7781. UNSOLICITED MANUSCRIPTS MUST BE ACCOMPANIED BY RETURN POSTAGE. ALTHOUGH ALL REASONABLE CARE WILL BE TAKEN, THE EDITORS ASSUME NO RESPONSIBILITY FOR THEIR SAFETY OR RETURN. ALL EDITORIAL COMMUNICATIONS SHOULD BE SENT TO THE STAMFORD OFFICE. PUBLISHED AND ACCEPTED AS CONTROLLED CIRCULATION PUBLICATION AT ORANGE, CONN.



TECHNICAL MANAGEMENT

MERRITT A. WILLIAMSON

MAKING COMMITTEES WORK

I am sure all of us have attended more conferences and meetings than we like to think about. Some of these, in my own experience, have been well-handled and worthwhile; but by far the greater number have been poorly handled and largely a waste of time.

There are several reasons why meetings break down. Poor chairmanship, for example, can be a great deterrent to the enjoyment and value of the session. Being a good committee leader is a real art. There are a few books containing hints on this. One such book which every manager should own and study is "Standard Business Conference Technique" by Carl Heyel, published by Funk and Wagnalls. This book lists 136 rules covering every phase the preparation for the conduct and the follow-up of a business conference—and shows too, how each of these steps should be organized and planned for maximum results. Special attention is given to the problems of the staff executive in conference leadership, as opposed to those of the line executive conducting a conference composed entirely of his own subordinates.

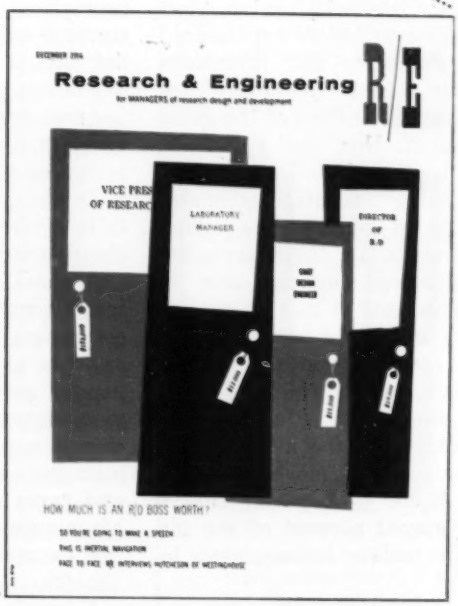
Important too is the failure to define in advance the objectives of the meeting. The technical manager must, in my opinion, be very clear and straightforward in his thinking where committee action is concerned. It is futile to appoint committees or to serve on them unless there is some conception of the job to be accomplished. I think that the person who names a committee should make a definite charge in writing to the committee which will limit the functions and permit the committee to recognize when its job is done. I think that every person named as chairman of a committee has the obligation to set forth objectives and to prepare a formal statement of his understanding of the purposes and limitations of the group. He should then forward this statement for approval to the person who appointed the committee. I think it behooves every committee member not to move forward into discussion until the committee chairman and the committee itself are clear about the following questions:

1. Who is convening the committee?
2. Are the members appointed or elected?
3. Are committee members serving on the committee by virtue of their position in the organization or are they there as individuals?
4. Are they representing a unit of the organization or are they there as individuals free to contribute without regard to "party line"?
5. How is the result of the committee meeting to be reported: By advice to the chairman who will then take action or written as a statement which summarizes the members' agreements? (Can minority views be given?)
6. To whom does this report go? What does the recipient want to use it for?
7. Will the report form the basis for further study, or will it be the basis for immediate action?
8. Will the individual committee members take action off the cuff or will they wait for formal instruction before proceeding?
9. Will there be a secretary to prepare the minutes?
10. If there is a secretary, is he a member of the committee or an outsider without vote?
11. Will recommendations be brought to a vote?
12. If individuals are to take later action, is the recorder or secretary instructed to make these assignments a part of the minutes?

If the committee is a continuing kind which meets on schedule, I like to see that the minutes carry the names of those absent. I have found it very effective to carry two lists: those present and those absent. I further like to see that every person attending a regular meeting sends a deputy when he cannot be present. This gives the deputy training, fosters better communication, and allows the one in charge to see who is really developing the men under

(*Continued on page 36*)

Formerly Research Director for Burroughs Corp., Dr. Williamson is now Dean of the School of Engineering and Architecture of Pennsylvania State University. He also acts as a consultant on problems in technical administration to industry.



CHANGE . . .

We are all familiar with the adage that "nothing is constant except change". As publishers of the only magazine serving solely the managers of industrial research, design, and development, we would amend that adage to read: "In product and process development, nothing is constant except change **for the better**".

You will have noticed the new front cover design of this issue of RESEARCH & ENGINEERING. This was not changed for the sake of change itself. It reflects the advanced, enlarged editorial scope which begins to become evident with this issue; which will hit full stride with the January and subsequent issues in 1957; and which is an indication of . . .

MORE CHANGES TO COME . . .

With the January issue we are also reducing the page size of the magazine from its present 9-¾″ x 12-¾″ size, to 9″ x 12″—a change recommended by the tens-of-thousands of orders for article reprints: the new format will be a filing convenience.

Further, our editorial staff has been enlarged to cover the greater scope of editorial service; we are also adding consulting editors located in areas of greatest industrial activity. However, the latter will supplement, not supplant, the travels of our own staff which averaged 1000 miles per month in 1956 and will increase in 1957.

At this time I join our editors in wishing you a joyful holiday season and a prosperous 1957.

Wm. H. Relyea, Jr. **Publisher**

HOW MUCH IS AN R/D

In the past twenty years a torrent of technological change has brought America more material gains than any nation has ever before experienced in history. Processes and inventions which did not exist 20 years ago now account for over $30 billion of the gross national product. Nor does the trend show any sign of diminishing. The Bureau of Labor Statistics estimates that about 1000 more companies added R/D departments to their organizations this year, raising the total of companies thus staffed to 16,500.

This gives rise to a paradox. For, despite the growing number of companies climbing aboard the R/D bandwagon and the resulting shortage of technical executives, the average R/D director's salary has moved so sluggishly (up $2,000 in 5 years) that it has merely stayed abreast of the median rise in middle management incomes.

Fact and Fancy

This fact flies against a number of popular assumptions about the R/D director's pay. One widely-held view, for example, is that technical managers are enjoying a Midas prosperity. And the widespread publicity which popular magazines have given to engineers' starting salaries has bolstered the belief that a technical degree is almost a guarantee of a quick fortune.

Another article of faith in the business community is that all good managers tend to be promoted, and that the R/D manager is no exception. So if he fails to rise in the company, it is probably his own fault.

A final assumption concerns the trend toward giving research directors extra benefits—such as pensions, stock options, and bonus arrangements—in lieu of salary. A growing number of management people are convinced that this is a desirable development. As a manager's income climbs above $15,000 and taxes consume more and more of his income, he stands to gain by accepting payment in the form of deferred benefits.

How do these assumptions square with the facts? R/E, in a confidential salary survey of 153 research and development directors in all industries found that, as far as technical managers are concerned, these assumptions may be invalid.

For one thing, despite the much-publicized shortage of scientists, R/D managers appear to be no better off financially than executives in non-technical fields, such as personnel, where supply far exceeds demand. R/E's sampling shows that the average technical manager's salary in three industries—electronic, chemical and mechanical — is about $19,000, which represents a three percent per annum rise in salary since 1951.

The adage that good managers get promoted may not apply to the research department. In the average manufacturing division, six levels of management separate the foreman from the general manager. By contrast, the average research and development department in R/E's survey has only three levels to rise through. As a result, opportunities for promotion within research are somewhat limited. Of 153 research managers interviewed, a surprising proportion—36%—report that they have never been promoted by their present employer. Most of their salary gains have come about by changing jobs. Less than 34% have received two

General Manager — Research & Development
$15,000

Vice President — Research and Engineering
$65,000

Director of Basic Research
$11,500

BOSS WORTH?

SCOTT NICHOLSON associate editor

or more promotions.

Finally, R/E's survey indicates that the sum of benefits and bonuses that the typical R/D director receives does not fully compensate for the lag in his salary. Though more and more R/D directors are participating in company benefits (72% of R/E's respondents report that they receive some form of deferred payment), the type of benefits which they receive are not necessarily those which fatten the pocketbook. For example, whereas 76% of R/E's respondents participate in some form of *contributory* pension or insurance, less than 20% enjoy a company-paid insurance plan. Also, while 34% are offered a stock option, less than 12% enjoy a profit-sharing arrangement.

In short, R/E's survey strongly indicates that three of industry's favorite assumptions about R/D managers' pay may be partially or wholly inaccurate. The R/D director is not, as one financial newspaper put it, "cashing in on the scientific shortage".

Money Secondary

Why is the present technological prosperity bypassing the very group that set it in motion? One answer, of course, lies in the nature of the R/D manager himself. Acquiring wealth is not his main objective, and he is frequently happy to accept low pay for the chance to work unmolested. As the technical director of a large Midwestern machine tools producer explains, "creative work has never been able to command a high price tag. . . Usually a research director makes heavy salary concessions for the right to work in a free atmosphere".

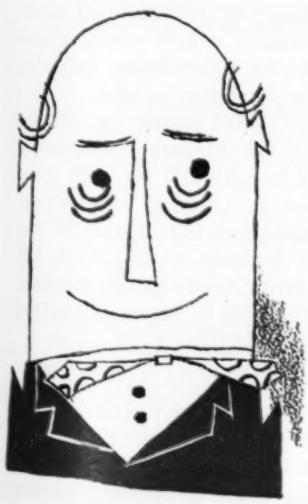
The research director of a medium-sized chemical company even suggests that lack of interest in financial rewards is one of the signs of a good scientist. He writes: "In reply to the question about the research director's pay, I would say that the person whose main goal is to contribute to scientific knowledge is probably worth more than he's getting, while the one who is interested in accumulating money is probably getting more than he's worth".

But apart from the research manager's reluctance to make money a prime consideration, other factors are also at work to depress his salary. The various techniques that companies use to judge

HERE ARE SOME OF THE QUESTIONS R/E ASKED

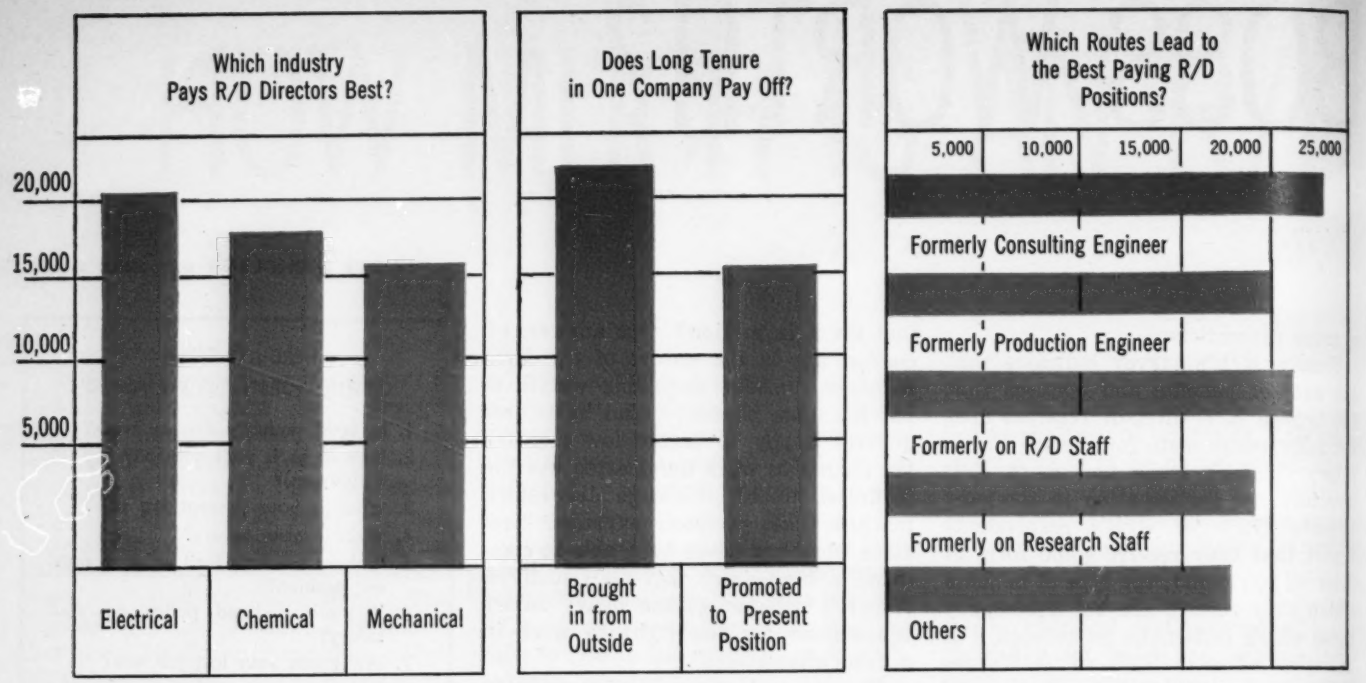
1. In which industry do you work?
2. How large is your company (no. of employees)?
3. What is your present job title?
4. What is your salary?
5. Is there a salary limit on your present position?
6. Is there a fixed policy on your salary?
7. What was your last job title?
8. Were you promoted to your present position or brought in from outside?
9. What was your salary just prior to accepting your present position?
10. What is your age?
11. What benefits does your company offer you?
12. Do you consider yourself 1) grossly underpaid, 2) worth considerably more, 3) satisfied with your present salary progress, 4) perhaps somewhat overpaid?
13. Do you feel that you earn the same, more or less than R/D administrators in other companies?
14. Are you paid the same, more or less than other managers in your firm?
15. Please comment.

Laboratory Manager
$17,000



Director of Preliminary Design
$25,000

Technical Manager
$16,500



the R/D manager's worth may be one of the reasons why raises come slowly. Industrial relations specialists generally agree that the research director's role is one of the most difficult to evaluate. The work is intangible, and results are hard to pinpoint. The technical director of a chemical laboratory points out, "In R and D there is no clearcut yardstick of achievement. The sales department's percentage-of-sales concept or the piecework measurement that applies to production has little or no application to research. In R and D, the success of the individual director has to be measured in much the same way that you measure top management's performance—by the over-all profit picture of the company".

In the absence of tangible yardsticks, how do most companies judge the worth of their research directors? The replies to R/E's questionnaire indicate that most companies meet the problem by applying the same evaluation techniques to research that have become standard in other departments. Three of the most common of these are:

- the uniform salary scale
- the point system
- the Boss' opinion

Paying the Job, Not the Man

According to R/E's survey, the uniform salary scale is one of the most common evaluation systems that R/D managers must live under. Thirty-eight percent of R/E's respondents report that their pay falls under this approach. The scaled system has two identifying characteristics.

- The salary is pegged to the job rather than to the individual. That is, each position—each square on the organization chart—carries its own price tag regardless of the person who happens to occupy the post.
- The allowable salary spreads are kept within close limits. Each position bears a bottom and ceiling salary, with a range of three or four thousand dollars between.

Companies that use this technique offer several reasons why they like it. One is that it permits company-wide uniformity and thus avoids the charge of favoritism. As a personnel manager observed, "Every manager, every employee even, is convinced that his own work is the most important in the company. It's good that people feel that way. But if we try to rank men according to their real, intrinsic worth, we will simply demoralize the ones who have been bypassed. It generally pays off to be impersonal in dealing out salaries".

The personnel director of a large Eastern electronics manufacturer employing over 12,000 persons stresses a second advantage of the salary scale: It keeps managers striving after the next rung in the organization ladder. By limiting the pay that a manager can receive in his present position, it whets his desire to move ahead. As a result, it encourages managers to prepare themselves for promotion.

R/D directors answer, however, that applying the uniform salary system without regard to the differences between research and other types of work may lead to serious injustices. Too often, for example, companies fail to realize that the research director's job is a relatively fixed professional assignment. In other departments, such as sales and production, it pays to shuffle men through a variety of assignments. But the research director, with his graduate training in science is usually too useful right where he is to be transferred either upstairs or sideways. As a result he frequently remains stationary. Under a stratified salary scale, where raises depend on promotions, this can work a serious hardship on him.

Another way that basing pay on the job penalizes the research director is that it tends to withhold rewards from men who deserve special recognition. R/D men point out that research and development depends on the man, not the job. By tying salary to the position, this approach tends to ignore the gifted engineer's contribution.

Earning Gold Stars

How can companies pay each R/D director according to his individual contribution without opening the charge of favoritism? Many companies answer

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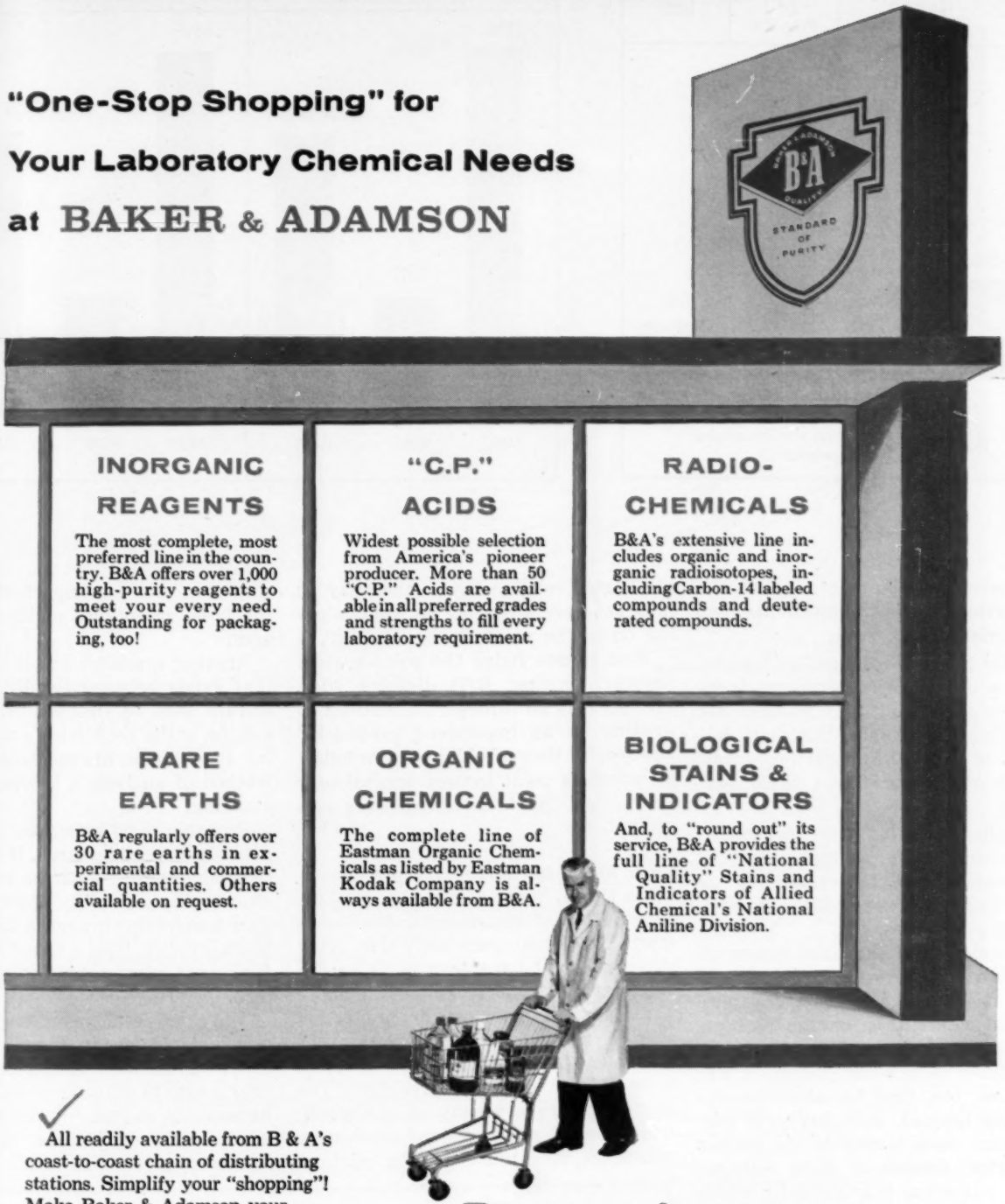

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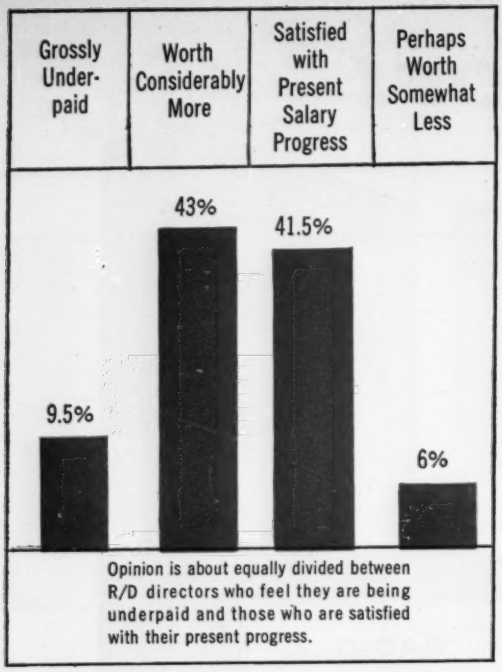
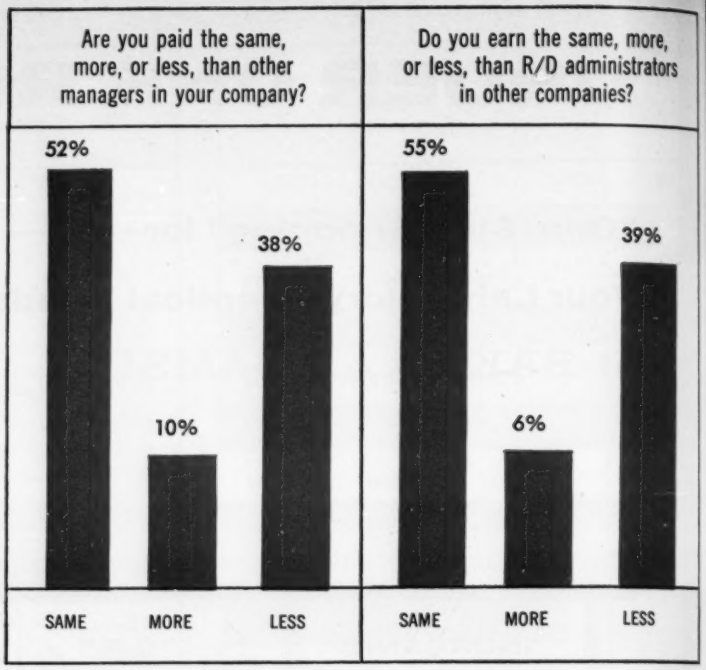




this question by applying an elaborate point system. This approach has two characteristics.

- It rates the R/D manager on his performance of specific supervisory functions. For example, it may measure his success in handling subordinates, in delegating, in expediting paperwork, dealing with other department heads, and so forth.
- It applies a specific numerical weight to each function. For example, handling subordinates may be valued 25 as against 20 for ability to co-operate with company procedures.

Companies using the point system of rating like it for several reasons. One is that it focuses on the manager's performance rather than on the position he holds. Also, it lets him know on which skills he is being judged. It lets him know, too, that his activities are not being ignored. And finally, it permits much more leeway in the matter of salaries, because it gives management a numerical tally-sheet by which to justify extensive raises.

However, R/D managers find two dangers in applying the point system to research and development activities.

It sets up artificial standards, they say. The criteria it establishes too often have nothing to do with the successful functioning of a research laboratory. "In nine cases out of ten", the director of chemical research in a Pennsylvania company declares, "the criteria used are human relation ones which may or may not have a bearing on what is going on in the research department".

Most bosses fudge the point system anyway, another R/D director adds. "Bosses only go through the motions of grading by an impersonal yardstick," he says, "if they actually were to follow an accurate point system scrupulously they would lose their control over subordinates."

What About the Boss' Opinion?

Isn't the boss, after all, the best judge of what his research director is worth? R/D managers reply that much depends on who the boss is. Is he the company president, technical vice president, general manager, or production manager? R/E's survey reveals that about one-third of the R/D directors report directly to the president. The rest report to a variety of vice president, general managers and production managers. And this reporting relationship can have an important effect on the boss' acceptance of his R/D manager.

Another consideration is the rapport that exists between the R/D manager and his boss. Do they see things eye-to-eye, or is the technician's way of looking at problems, his vocabulary, and his method of analysis a barrier to understanding.

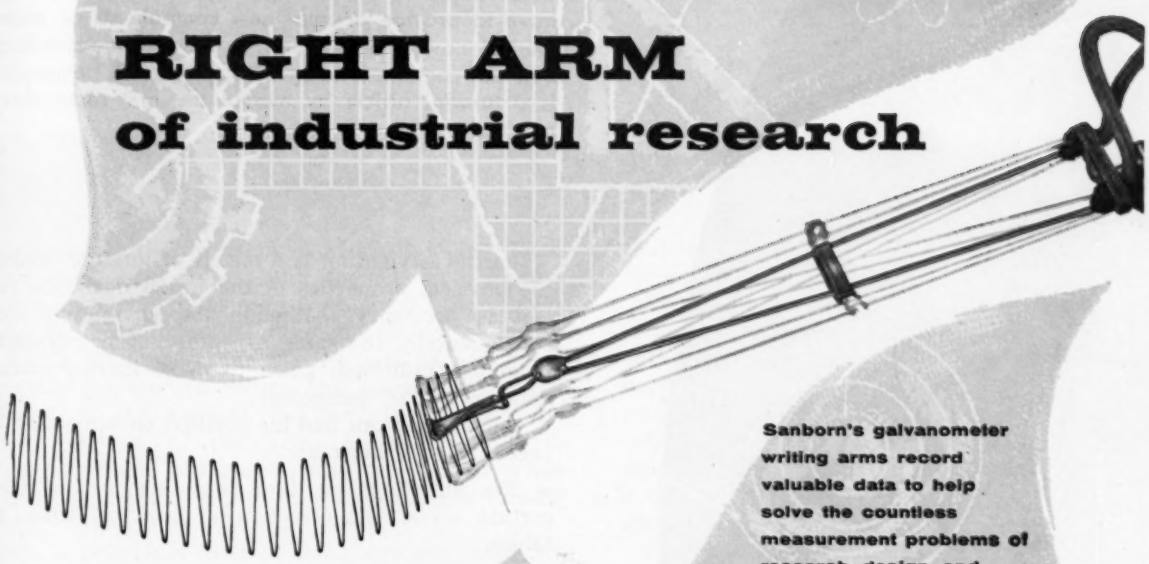
Probably most important is the boss' attitude toward research. If his outlook is a pioneering one, if he becomes excited by the possibility of attaining product leadership through a technological breakthrough, then a sound basis exists for a good relationship between the two men.

The chief development engineer of an electronics company sums up with the following advice; "If a research manager wants to get paid what he's worth, he needs to do just one thing: work for a president who believes in the possibilities offered by science".

SEVEN TYPICAL SALARY SITUATIONS FROM R/E'S SURVEY

TITLE	INDUSTRY	AGE	SALARY	REPORTS TO
Director of Research	Chemical	52	$18,000	President
Chief Engineer	Mechanical	34	$11,500	Technical V.P.
V.P. — Research	Mechanical	48	$21,000	President
Manager of Research	Mechanical	41	$ 9,400	General Manager
V.P. & Technical Dir.	Chemical	49	$30,000	President
V.P. — Research	Electronic	44	$26,000	President
Director—Res. & Dev.	Electronic	38	$17,500	V.P. Res. & Eng.

RIGHT ARM
of industrial research



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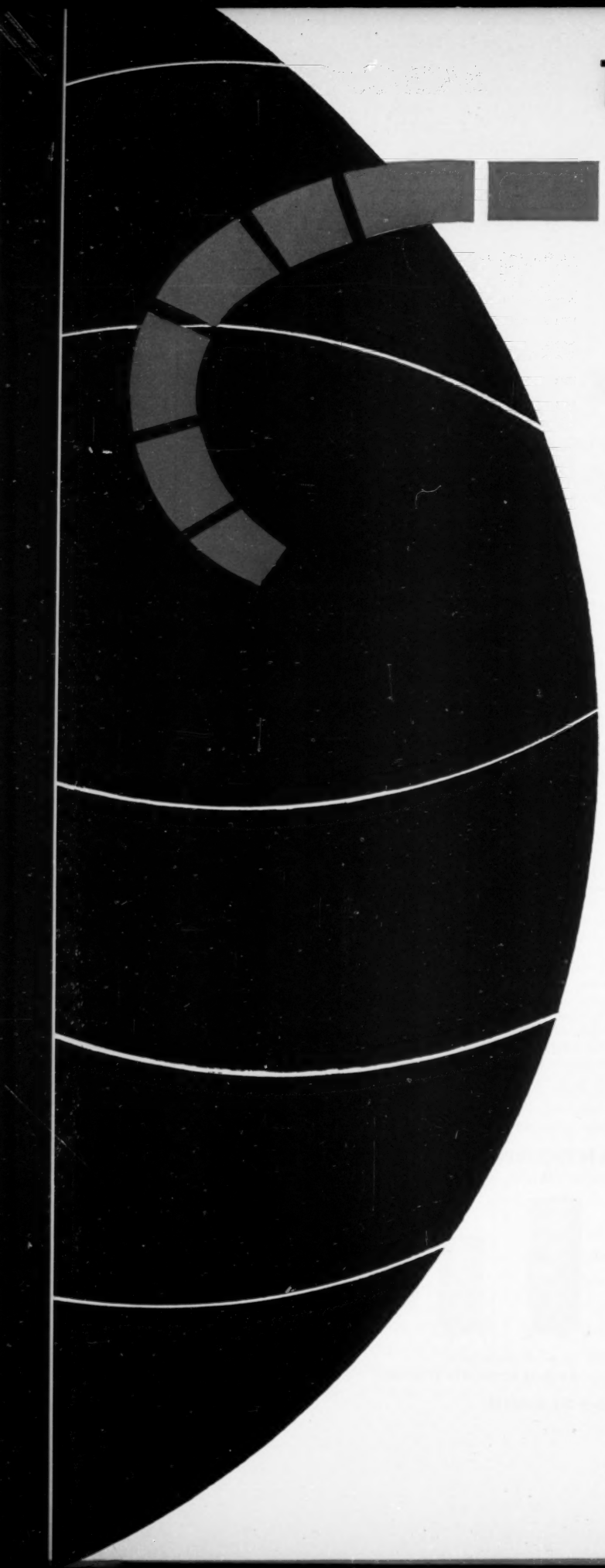
THIS IS INERTIAL NAVIGATION



Some day soon your design department or laboratory may have to provide unusual new components or materials for inertial navigation systems. A basic understanding of this new self-contained navigation system will be essential. Here is a tutorial article by two of the first researchers in this new technology.

Inertial navigation is a means of guiding vehicles using the physical properties of the Earth itself: no radio contact is necessary. Although the navigation problem is fundamentally the same as before, it is changed enough from its traditional guise to make inertial navigation a new branch of technology.

A navigator can find his position on some map by reference to three sources:

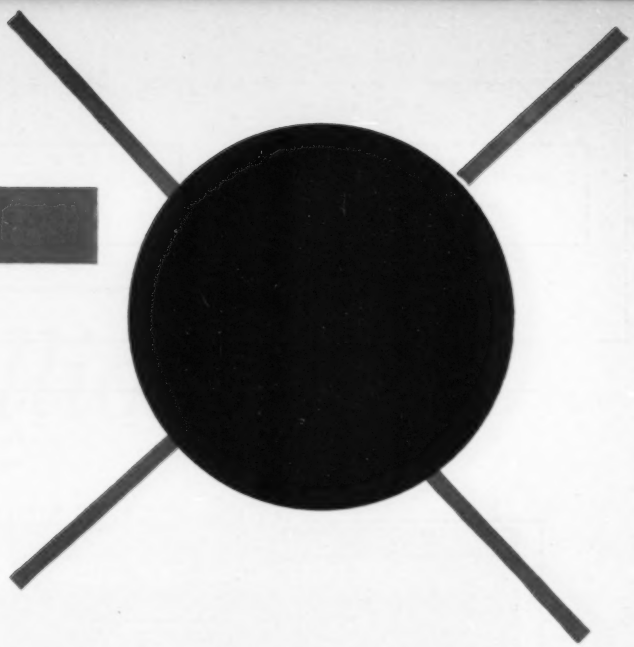
- The directions of lines from his present position to certain stars, the direction of gravity, time, and star tables.
- Intelligence communicated—by radiation techniques—from the Earth.
- The physical properties of the Earth. The physical properties of the Earth that may be used include the direction of gravity (the vertical), magnetic North, and the direction of the Earth's axis of rotation.

The navigator wishes to know his present position: for example, his latitude and longitude. A continuous knowledge of his present position, plus some stored information on his past position (a plot of his course, in effect), will tell him where he is going—with respect, always, to some preassigned map or grid, or, speaking generally, model of the Earth.

Astronomy in a Closet

Inertial navigation is defined as the determination of a vehicle's position from *within the vehicle* by correlation of the local vertical, with a reference frame maintained by means of gyroscopes. It could be called "navigation, or astronomy, in a closet." Thus inertial navigation systems are, or can be, completely self-contained and need not have recourse to radiation to or from the Earth to determine position.

The direction of gravity is unique at any point on the Earth and changes by one minute of arc for every nautical mile travelled over the Earth (except for small variations due to gravity anomalies and ellipticity). The direction of gravity, i. e., the vertical, thus is the defining parameter identifying position on the Earth. The determination of the vertical appears at first to be a simple procedure: it seems merely necessary to carry a plumb bob or a



JOHN HOVORKA WALTER WRIGLEY

pendulum and note the direction in which it hangs. Then as the vehicle moves over the Earth, the pendulum appears always to point down, or as seen from aboard the vehicle, in nearly the same direction although (since the model of the Earth is a spheroid) the vertical is effectively rotating about the Earth's center. This essentially *geocentric* rotation of the vertical, in fact, is the basis of the above definition of the mile: a nautical mile is the distance between two points near the equator when the angle between their respective verticals is one minute of latitude.

However, a pendulum used in the above way does not indicate the vertical correctly in an accelerating vehicle. Devices used to indicate the vertical cannot distinguish between gravity and the inertial reaction effect of linear accelerations (Fig. 1). Artificial horizons attempt to filter out the disturbing acceleration effects, and so achieve an accuracy of approximately one degree in flight for the measurement of the vertical. For precision indication, the sphericity of the Earth is taken advantage of in designing vertical indicators, so that their measurements are not disturbed by vehicle accelerations. Thus, the shape of the Earth is a further physical property made use of in inertial navigation. Such devices use the property that gravity and acceleration represent a direction plus the essentially geocentric angular acceleration of that direction. Thus they should be treated together. This was done by Schuler[3,4] and gives rise to the 84-minute pendulum.

The Vertical Indicator as an Equivalent Pendulum

Since Schuler-tuning of a pendulum is difficult at best, it is usual to simulate the Schuler-tuned pendulum with an equivalent pendulum, having the form of an electromechanical feedback system designed so that it acts as if it tracks the true vertical, although it actually tracks the apparent vertical. Here, tracking means the process of matching (i.e., bringing into coincidence) two spatial directions: the true vertical, or direction of gravity, and the *indicated*, or controlled, vertical. Thus, the tracked line is an externally established direction, while the tracking line is internally fixed in the vertical indicator.

The vertical indicator is a closed-loop system; an elementary form for such a system is shown in Fig. 2. Note that the system *input* is the direction of the net non-field force per unit mass, or specific force, on the vehicle.

First examine the block marked *space integrator* in Fig. 2. The space integrator is usually the system component with respect to which the indicated vertical is fixed. The space integrator is taken to be coincident with the point from which the true vertical is observed. Therefore, only rotation—no translation—of the indicated vertical is needed to drive it into coincidence with the true vertical. It is one function of the space integrator to perform this operation.

To simplify the block-diagram representation of the vertical indicating system in Fig. 2, only a single-axis sys-

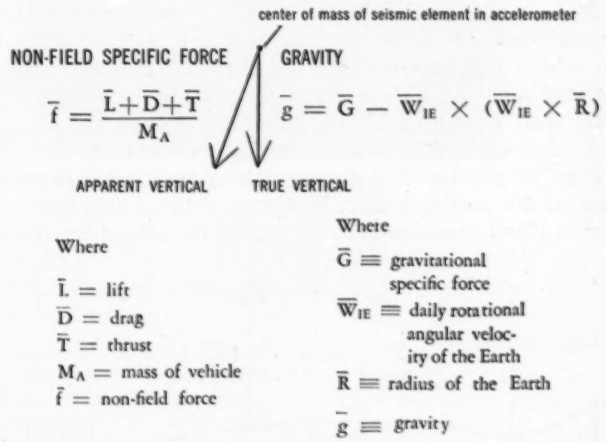


Fig. 1. The true vertical or gravity direction, compared with the apparent vertical as indicated by a pendulum.

tem is shown. The problem represented is thus one where vertical indication is required in a single plane rather than in three dimensions. (The two-dimensional treatment is not restrictive provided certain cross-coupling and azimuth rotation effects are taken into account.) With the single-axis limitation, it is possible to show the controlled member drive system, i. e., the space integrator, on the block diagram as a box, with the indicated angular velocity of the indicated vertical itself, as the output. The angular-velocity-in direction out requirement on the space integrator is

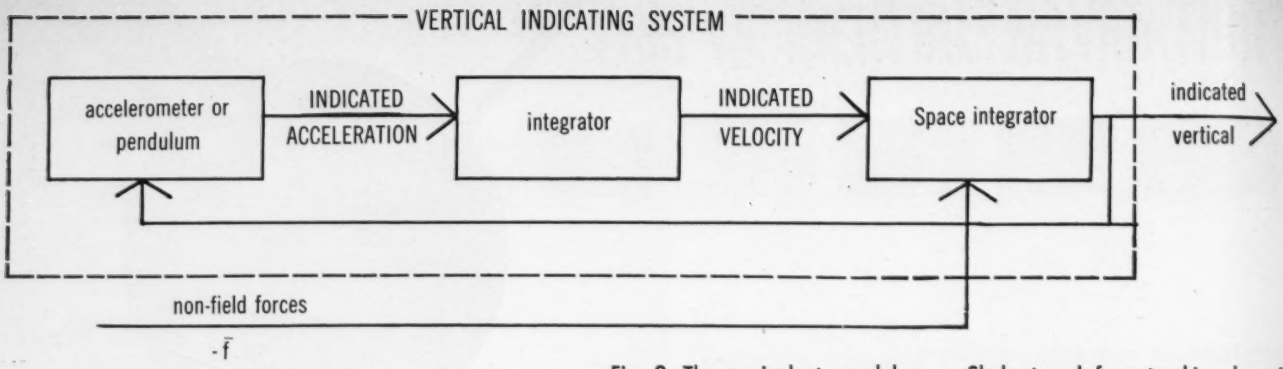


Fig. 2. The equivalent pendulum: a Shuler-tuned force-tracking loop for vertical indication. Only a single-axis system is shown.

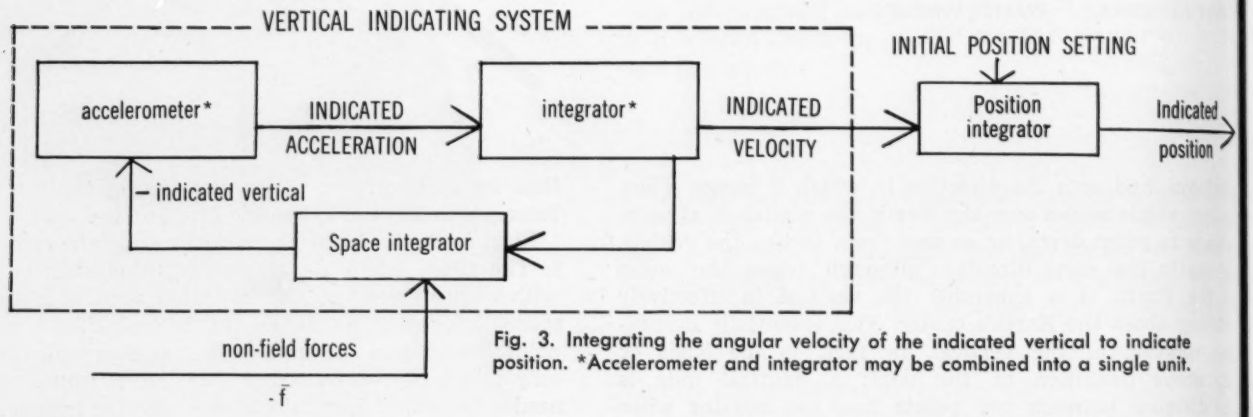


Fig. 3. Integrating the angular velocity of the indicated vertical to indicate position. *Accelerometer and integrator may be combined into a single unit.

taken care of by the use of gyroscopes.

Primary Data Source Is an Accelerometer

Since the true vertical is "seen" by the system as the direction of a force, a primary data source in the system is a force or acceleration detector, i.e., an accelerometer. If the accelerometer is stationary on the Earth, and the platform on which the accelerometer is mounted is horizontal, a fiducial mark on the controlled member indicating the vertical then lines up with the direction of gravity; i.e., the indicated vertical lines up with the true vertical. No component of gravity then appears along the horizontal input axis of the accelerometer. However, if the controlled member is tilted, a component of gravity is sensed by the accelerometer along the accelerometer input axis.

The controlled member indicating the vertical is hinged or gimballed to a base which is in turn rigidly attached to the vehicle. Mounted on this controlled member, the accelerometer senses any accelerations of the base which may present components to its input axis.

A careful analysis of accelerometer inputs shows that such a unit responds to the non-field specific force given by the combination of lift, drag and thrust per unit mass on the vehicle, rather than to field force, (e.g., gravitation), as shown in Fig. 4. The direction of this force $\bar{f}$ is along the *apparent* vertical, in general (see Fig. 2). The true vertical is given by the direction of gravity, which is a combination of the Earth's gravitational (mass-attraction) force per unit mass with the centripetal specific force due to the Earth's daily rotation. The accelerometer is thus not to be identified with the vertical indicator itself; it is only one component in the vertical indication system. In Fig. 2 the accelerometer output is shown feeding an integrator as part of a *Schuler-tuned loop*, that is a feedback system which has the same natural period as a Schuler-tuned pendulum, or about 84 minutes.

The vertical indicating system is itself only part—although the principal sub-system—of the complete position indicator. Here by *position indicator* is meant a device which indicates latitude and longitude, as well as azimuth. This last quantity, although essential to terrestrial navigation, will not be discussed further here. The relationship of vertical indication to position indication is made evident from a study of Fig. 7, where latitude and longitude are shown as the angles between local and reference verticals, or as projections of these on the equatorial plane.

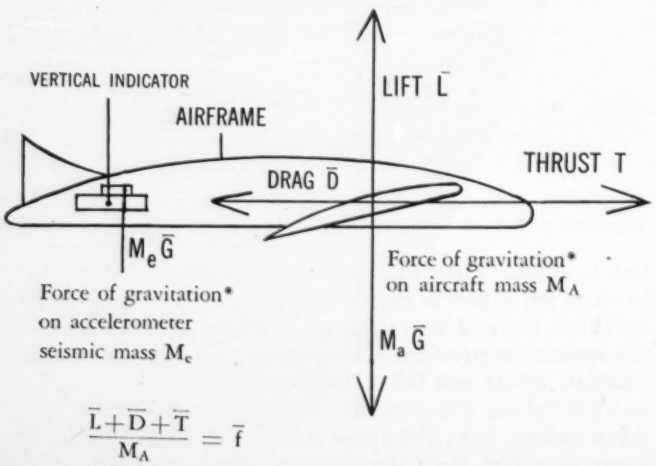
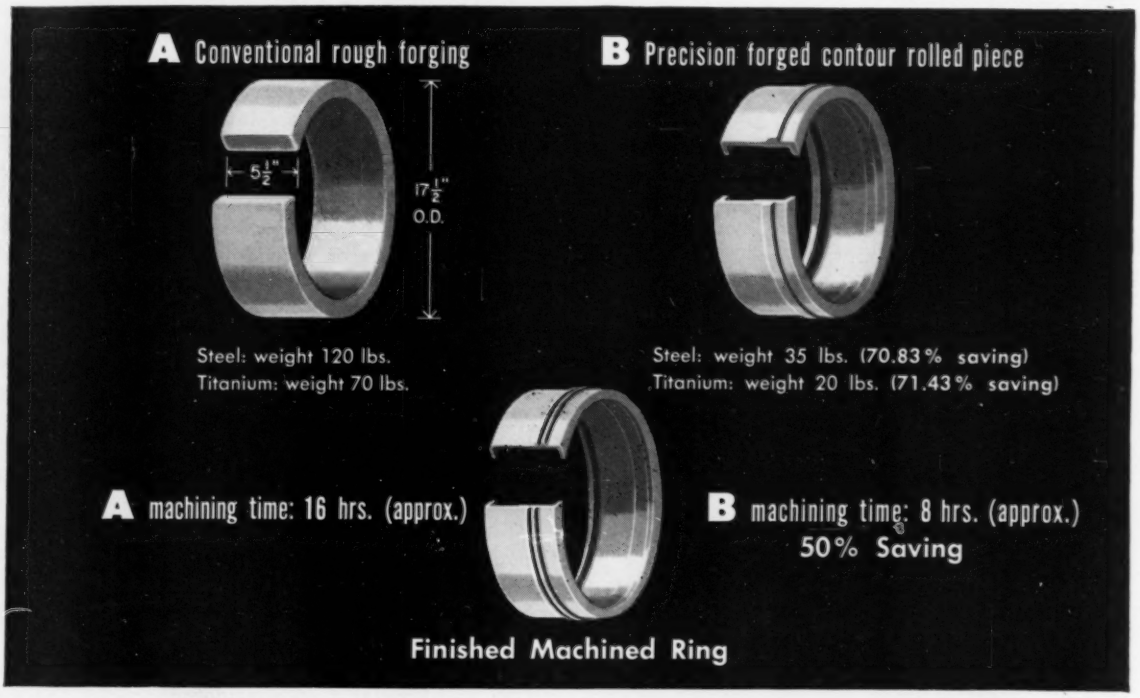


Fig. 4. The force an airborne accelerator measures: the combined effect of lift, drag and thrust. *The effect of gravitation is identical on accelerometer mass and aircraft.

(*Continued on page 42*)

The difference in these processes could be ***worth millions*** *to your company*



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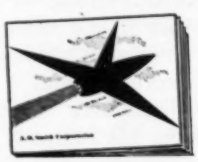

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FOR MORE INFORMATION CIRCLE 4 ON PAGE 48

Luis J. A. Villalon
Management Affairs Editor

SO YOU'RE GOING TO

Back in college, while the English Majors were taking courses in public speaking and manning the debating team, the fellows who now manage America's research and development programs were burning the midnight oil in a laboratory or wrestling with the intricacies of differential calculus.

That tended to be okay with them. They hadn't come to college to exhort their fellow-students or to prepare for a career on either the pulpit or the podium. All they really wanted was to be left alone to tinker, design and invent.

But they were born too late for any such ivory tower existence. During World War II science broke out of its isolation ward and became a matter of violent public—as well as corporate—concern. Members of the technical community suddenly discovered that it was not sufficient to be seen and not heard. They began to be asked to speak up at company conferences and to take their places with other company executives at general business meetings. As a final accolade, they even had a few after-dinner dates thrown their way.

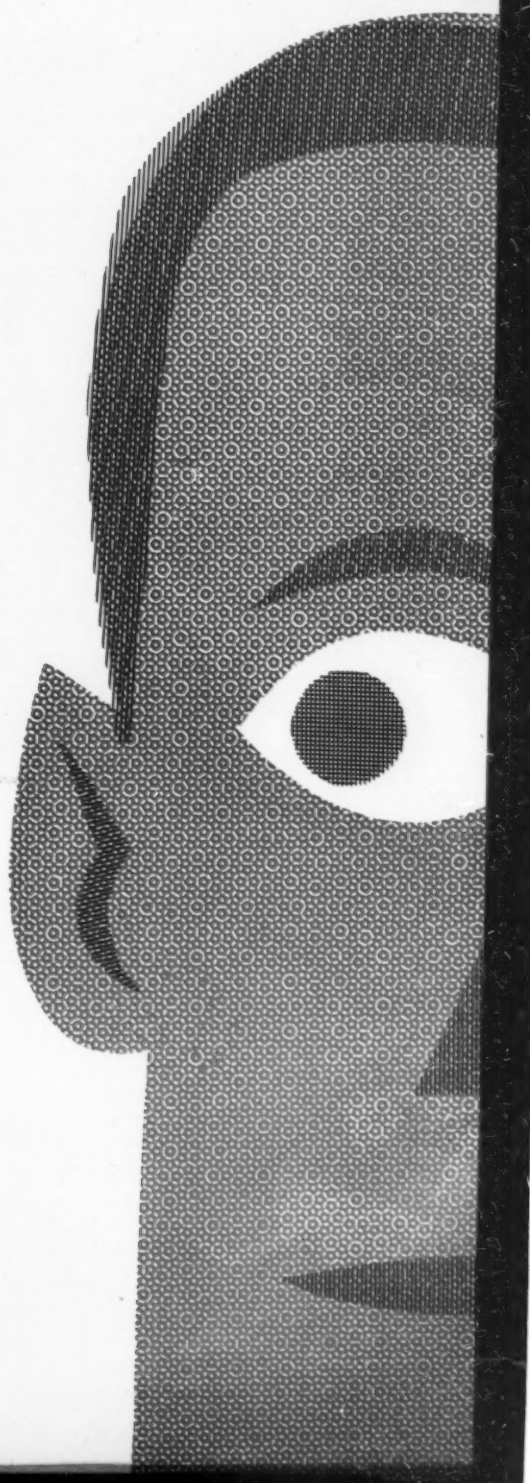
H. B. Maynard, president of the Methods Engineering Council—himself engineering-trained—puts it this way: "The time has come when the scientist-technician can no longer live within the four walls of his laboratory. He must be able to contribute to both corporate and public understanding of the scientific point of view. Furthermore, effective speaking is now considered one of the measures of executive success. It's a new skill which the progressive manager must master."

The technical man deals with facts and knows full well that it's important to have something to say before you say it—but, unlike his brother in the sales department, he doesn't always realize that the way it's said counts, too. The executive who can talk coherently and convincingly not only has an edge with his listeners but is likely to get closer to what he wants from his company, both for himself and for his department.

Fortunately, except for the extremely shy and unassured, reasonably effective speaking is not difficult to come by. And, actually, those who are this shy and unconvinced of

Research-conscious industry no longer lets the research and development genius hide out in his laboratory, to be seen and not heard. Now he's expected to speak up at company conferences and take his place alongside other company executives at general business meetings. Here are some guides to effective speaking that will help him shine on the platform, conference table, or after that professional society meeting.

TO MAKE A SPEECH



their own abilities very seldom get into a management job.

It's important to remember that it's not necessary to be a Churchill or a Stevenson to speak more effectively than does the average man. The objective of any speech course for business is a limited one, designed only to turn the dull and halting speaker into an assured and effective presenter of facts—not a Billy Graham.

Speech training for industry has become a big business in itself, and there is no doubt that pioneer Dale Carnegie has helped many a company executive along the road to more effective speaking. Other methods range from company seminars to the successful textbook-record technique that has long been used to teach languages.

This article is not, of course, designed to take the place of a full-fledged course in public speaking, but it will round up some sound advice from industry's top speechmakers as well as some easy-to-take lessons in effective talking.

In some of the following exercises a recording or dictating machine will be valuable. If one is not available, pair up with a fellow-sufferer and work out on each other.

All good speech training courses have one piece of advice in common—be yourself. Don G. Mitchell, chairman of Sylvania Electric Products and one of industry's most successful speakers, has said: "The more natural a man is, the better does he go over. A man with a real message and with sincerity can, as a rule, command attention. Stunts and stories should be used sparingly by the man who can't put them over well. A flat joke is worse than no joke at all."

Most people speak much better in private conversations than they do in public. The first objective is to bring their public speaking up to the level of their normal expression, to their wife, friends, and business associates. After that has been achieved, there's plenty of time for histrionics.

In a speech, one is concerned with three phases—the tools, the text, and the triumph. Tools refer to a set of weapons that every speaker uses, knowingly or otherwise. They are entirely learnable and have very little relation to degree of talent. The text is the manuscript, itself—its con-

(*Continued on Page 31*)

General Electric Now Offers Three Nuclear Research Reactors

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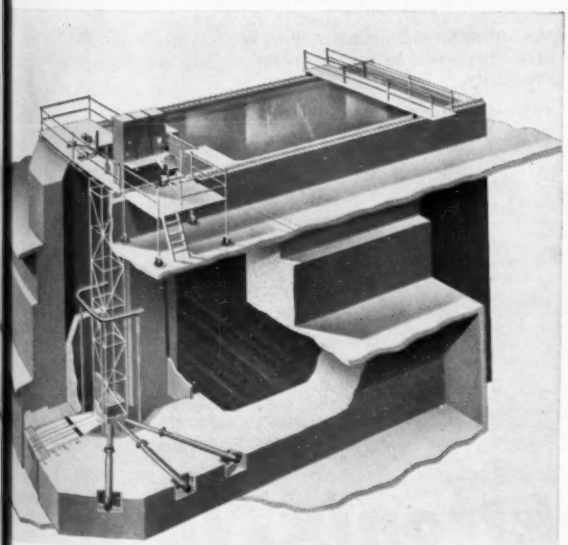
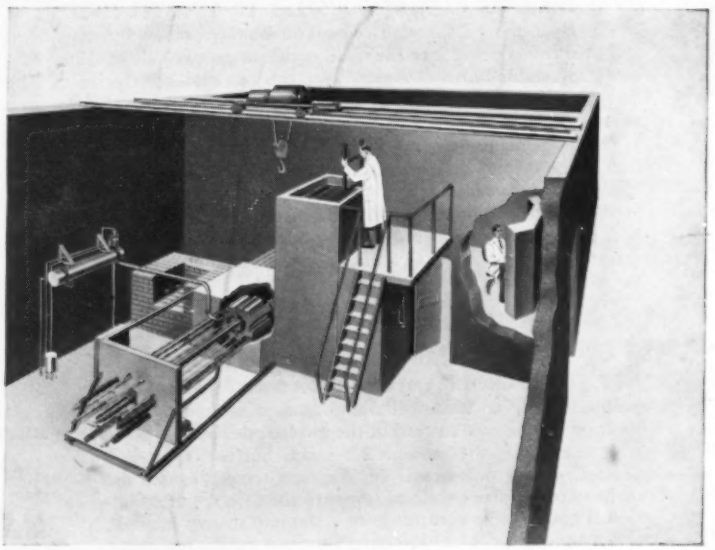


SWIMMING-POOL REACTOR has a neutron flux potential of 10^{13} neutrons/cm^2/sec. over a flux area of 3700 cm^2. Fuel inventory consists of 3400 grams of enriched U-235.



NUCLEAR TEST REACTOR has a flux level of 10^{12} neutrons/cm^2/sec. when operating at a power level of 30 kw. Fuel inventory for this reactor is 2500 grams of enriched U-235.

FOR MORE INFORMATION CIRCLE 11 ON PAGE 48

FACE to FACE

R/E INTERVIEWS HUTCHESON OF WESTINGHOUSE

- *Accounting for research costs*
- *Recruiting foreign professionals*
- *Bonuses for technical achievements*
- *Diversifying into chemicals*

Dr. John A. Hutcheson, Vice President, Engineering and Research, Westinghouse Electric Corporation.

Dr. Hutcheson was interviewed at Westinghouse's giant new research lab near Pittsburgh, Pa., by the Editor of RESEARCH & ENGINEERING. The Editor's questions are shown in the darker type.

Since we will be discussing research and development, would you first state your definitions for fundamental, basic and applied research?

All research is the search for new scientific knowledge. Our definition of fundamental research is: Research, the objective of which is the addition to new scientific knowledge. Saying it in a negative way, our fundamental research program does not have any apparent immediate application to our products. Basic research, on the other hand, and I'm sure you will bear in mind that these are arbitrary definitions for our own purposes, is research in those fields where new knowledge is needed to improve our products, or to make new ones. Applied research, as its name suggests, is the application of the new knowledge obtained to the development of a new product or, perhaps, of a new process, chemical, metallurgical, or whatever.

You are going to spend a relatively large amount of time, effort, and money, on fundamental and basic research in contrast to a smaller amount on applied research. Are you required to justify this, in their own terms, to the stockholders and the board of directors?

Our top management has faith in the people who are running this show. The Laboratory determines its own program and makes no accounting of it in the terms that you have in mind. We do tell the Board of Directors from time to time what we are doing (and may I add here that I think we are very lucky to have a Board of Directors which is not only sympathetic to our point of view, but definitely encourages us in it). There are two forms of evaluation that we enjoy: one is that given by the scientific fraternity generally and their acceptance of our work as it is published in the scientific journals, the comments they make about it, the odd prize that our people pull down from time to time; and the other is the evaluation that one can make of a similar kind of work that was done in these laboratories one or two decades ago—more likely two than one. With the passage of sufficient time, the value of the work becomes clear.

Approximately 10 per cent of Westinghouse's sales dollar is being spent in R/D. Could you break that percentage down into how much you spend in the fundamental, basic, and applied, areas of research, and how much in development?

I can give you a rough cut at the answer. Of the total amount of money that is spent for research and development in the company, about 5 per cent goes into the operation of these labs, which I hasten to point out is not all of the research effort that is carried out in our company. So, I can only guess for you that, of the total amount, roughly 10 per cent goes into research as we have defined it here. I can be way wrong—it could be two-thirds of that, or twice that, but that's the ball park we're in.

Could you estimate how many of the research dollars being spent go for professional salaries?

The salaries for all the people in the place, which includes not only the scientists but the cop at the gate, the maintenance men, and this sort of thing, accounts for about 70 per cent of the total operation. Be careful of drawing conclusions from this because many of the things you see around here were built in our own laboratory and their cost includes some part of the salaries we are talking about.

Do you have any thoughts or plans concerning the future of fundamental research at Westinghouse?

Our present research operation is one in which we spend some 30 per cent of our total effort in fundamental research as defined. I think this will grow within the next few years until it will be about 40 per cent of our total effort. This is a perfectly arbitrary number that we

picked out of the air, but it is a number which we are aiming toward.

To what extent is civilian research versus classified or military research spread around the organization?

The work that we do for the military of a classified nature accounts for, perhaps, 5 per cent of our total effort, perhaps not that much. That's of the right order of magnitude. The rest is all done in the interests of the stockholder directly rather than as a citizen of the country.

Can you say specifically what particular areas of research work are stressed?

I would say the major, but not exclusive efforts in the laboratory are in the field of solid-state metallurgy, and in chemistry, particularly with respect to electrical insulation, and in physics generally.

We are particularly interested in the role of the chemist in electronics. Can you say what type of chemists you use and the ways in which they are applying chemistry to further the efforts of the electromechanical people?

We require all types of chemists in the field of physical chemistry, for example, we deal with the problems of purification materials for use in semiconductors. Organic chemists are important here. We'll have inorganic chemists again in fields of electrical insulation, and in lubrication, are becoming increasingly important as we later move to silicones and like materials. You might wonder why we are in these fields and why the chemical companies don't take care of our needs. This is because our needs are frequently unique. Our demand for the chemicals that are produced, is relatively very small and hence of little immediate interest to the major chemical companies. But to us they are critical, and for this reason, we have to do the work ourselves.

Will Westinghouse diversify into chemistry commercially?

To a certain extent we are already in the chemical industry. For example, at one time (I don't know whether this is still true or not) we were the world's largest producer of laminated plastic materials. These again we produced primarily because of our needs for insulating materials; but their uses in other fields—decorative, for example—has continued and we continue to supply them for that sort of application. In fact, we have two divisions that are strictly chemical in their operation—the Trafford Micarta Division, and the Plywood Plastics Division, so-called, down in Hampton, South Carolina. So there is always the possibility that we will diversify into chemistry commercially, although I think it is pretty remote. We have a tendency to stick to our knitting, and our knitting uses the yarn of the electrical industry.

Dr. Hutcheson was the key man in the design and engineering phase of Westinghouse's radar program during WWII. He was in charge of microwave research and the expansion and coordination of that company's nuclear research program. A graduate of N. Dakota Univ. he joined Westinghouse in 1926 and rose through the pyramid of management to his present post, held since August '55.

How do you get an effective job of research done?

You get the most competent people you can find, competent in the area in which you are interested in having the research done. Then, let them choose their program and support them with everything that they can reasonably ask in the way of equipment, assistance, and the like. But the key to this thing is the competent man with ideas—competent, able to do research.

Is Westinghouse, in this particular laboratory, taking any steps to utilize some of the available technical brainpower of free Europe?

Yes. When we learn of individuals in Europe of the kind you have in mind, and find, as we often do, that these people would like to come to this country to work, we give them every opportunity to do that—help them get over here, and fix them up with good jobs when they get here. We do not, at this time, go for the idea of laboratories set up in Europe. I notice that many other companies are doing this. We gave this a lot of careful thought and for reasons that are perhaps unique to Westinghouse, we felt that this was something we could not do.

Do you have fixed ranges of base salary? Are there additional compensations—deferred compensation, bonus arrangements, or other types of financial incentives for R/D men?

We have a number of classifications of employees that have varying base salaries attached. These all overlap, so that in fact we have a continuous salary structure beginning with the lowest paid employee and running right up to the top pay given in the laboratory. Westinghouse has an incentive compen-

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FOR MORE INFORMATION CIRCLE 8 ON PAGE 48

sation plan for which the administrative employees in the laboratory are eligible. That is to say, if incentive compensation is to be paid in addition to salary, a number of the employees of the lab are covered by this plan and can receive incentive compensation. There are a couple of other forms of compensation that all the people in the lab can participate in. These relate to inventions. Each disclosure of a new invention is reviewed by a company-wide committee with the idea of finding the most valuable; and for those, the inventors receive an award of $50. On top of that, out of every 50 disclosures that are made from any organization in the company—the labs, for example—the one most likely to succeed is selected, and the inventor of this is given a couple hundred dollars. If there are co-inventors, $300 is split between them. On top of that, after patents have been issued, and have been in existence long enough so that their value can be determined, the inventors of the most valuable ones are recognized by special awards which may run from $2500 to $7500 per individual.

Do you have any unique organizational aspects, such as the supermarket approach to an individual's work supplies?

I don't think we have anything that would be called unique. We have the supermarket supply approach, as you put it, but at least one other place that I am aware of—Bell Labs. has it, too. Probably it's used elsewhere. It's just a nice convenient way of handling that particular problem. I am not aware that any other organization unit or system we employ is unique in this business.

You have an acting director, three associate directors, and one assistant director. Could you give some idea of how these men function as a team?

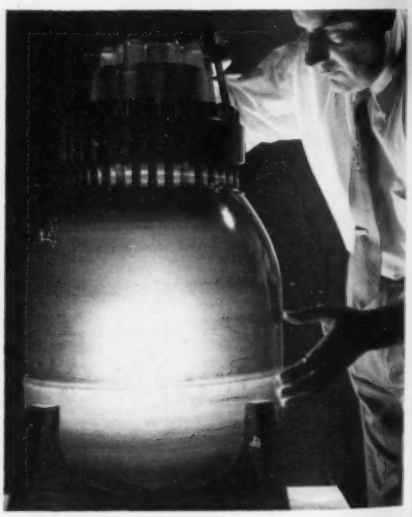
The acting director is given the responsibility of the laboratory as a whole. The associate directors help him in the technical direction of the work—if you can say research is directive. They help him in planning the overall programs which are brought into existence and in seeing that the existing programs are properly cared for. The assistant director, perhaps a more descriptive title for him would be business manager, worries about maintenance of the buildings, budgets, and that sort of thing.

Do the heads of the various technical sections here handle all their own administrative problems, or do you have a separate arm that gives them the administrative assistance they need?

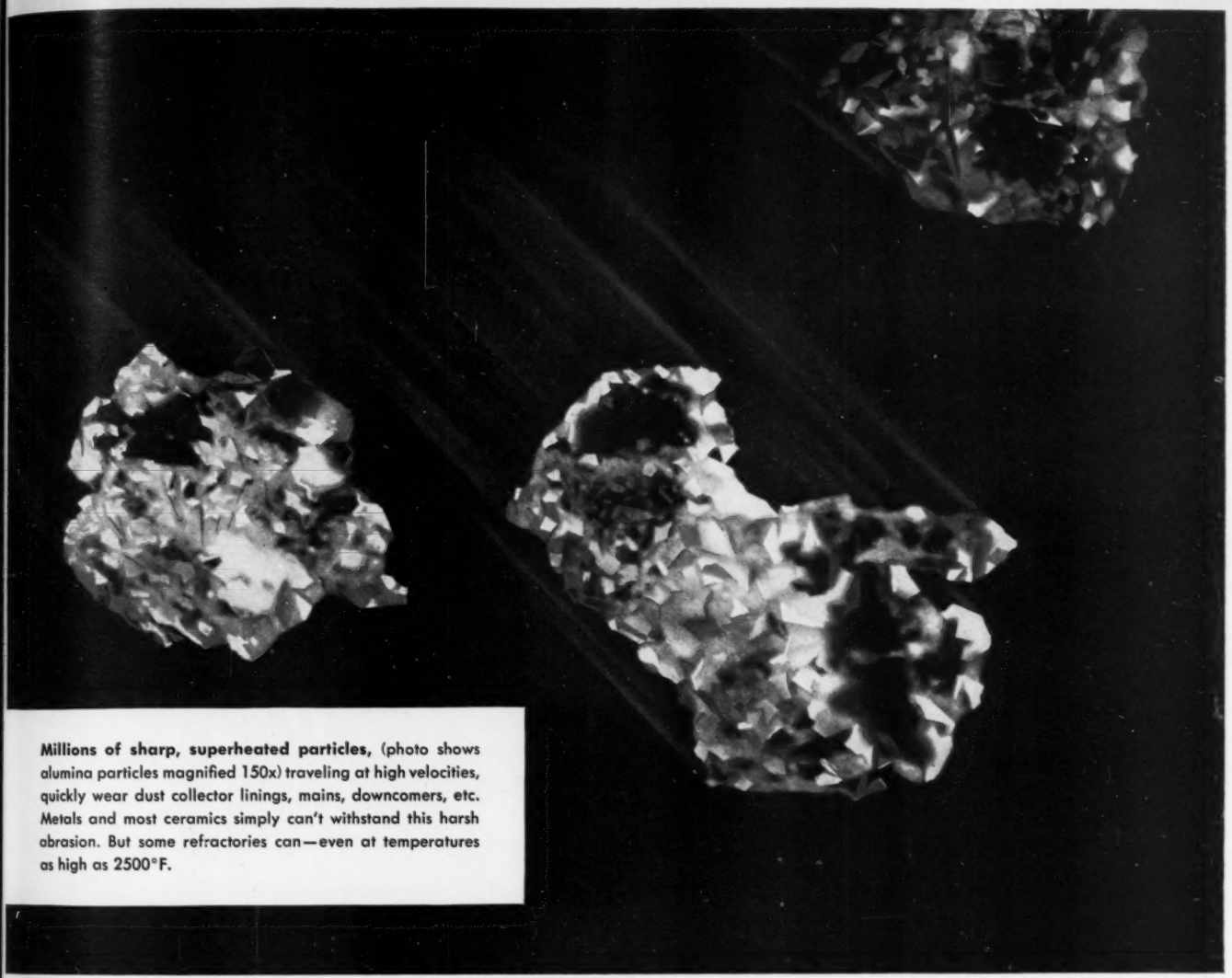
I suppose it's like any other place, it's a mixture. Where the scientific man happens to be an administrator as well, he usually ends up having both assignments. Where, as is more often the case, the scientific man is not an administrator or is a relatively less efficient one, this man, who nevertheless heads his operation, is given help in this way by an administrative assistant who takes care of the dull chores of life.

Does this Westinghouse laboratory have a set-up whereby a man can advance purely in the administrative line, purely in the technical line, or perhaps in a combination of both?

Any individual in the laboratory can progress just as far one way as the other—that is to say, the salary ranges for administrative work are paralleled by exactly the same salary ranges for workers whose contributions are purely technical with no administrative responsibility required or expected. Consequently, the individual is free to make a decision to follow that path which he thinks he will be most likely to succeed in. If he likes administrative work, he can go that way—if he wants to remain a scientist with no administrative responsibilities whatever, he can go that route and end up in the same place.



WESTINGHOUSE RESEARCH LABORATORIES' SCIENTIST uses glowing nuclear reactor model to study stresses deep inside the pressure vessel, or "shell," of a full-scale nuclear reactor. Built to exact scale, the model is constructed of a special plastic into which stresses corresponding to those in the real reactor are "frozen." Thin sections are then sliced from the model and examined under polarized light, where the stresses show up as patterns of colored light. Technique simplifies analysis of stresses; facilitates design of the vessel.



Millions of sharp, superheated particles, (photo shows alumina particles magnified 150x) traveling at high velocities, quickly wear dust collector linings, mains, downcomers, etc. Metals and most ceramics simply can't withstand this harsh abrasion. But some refractories can—even at temperatures as high as 2500°F.

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Unequalled resistance to abrasion whether caused by tiny gas-borne particles or sliding steel billets—is one of the most useful properties of CARBOFRAX® silicon carbide refractories. For example, a CARBOFRAX dust collector lining on an ore sintering machine is still in use after 10 years service.

And when abrasion is combined with high temperature, the exceptional resistance of CARBOFRAX super refractories becomes even more apparent and useful. When used in the exhaust lines of gasoline catalytic cracking units in temperatures ranging around 1200°F, these refractories lasted 3 years, as compared to alloy rings which lasted for 6 months. On a gas fired extrusion mill furnace—where steel skids lasted 5 weeks—CARBOFRAX refractories lasted 156 weeks.

Wear resistance is not the only unusual property of these refractories. They also offer heat conductivity roughly 11 times that of fireclay, with sufficient hot strength to withstand 25 psi at 1720°C. CARBOFRAX refractories are but one of many super refractories pioneered by Carborundum and offering a wide range of unusual properties.

Carborundum's new magazine "Refractories" pinpoints many practical applications for these unusual products. The forthcoming issue carries a feature article on "Wear Resistance". Send for your copy today.

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Please send me the forthcoming issue of "Refractories".

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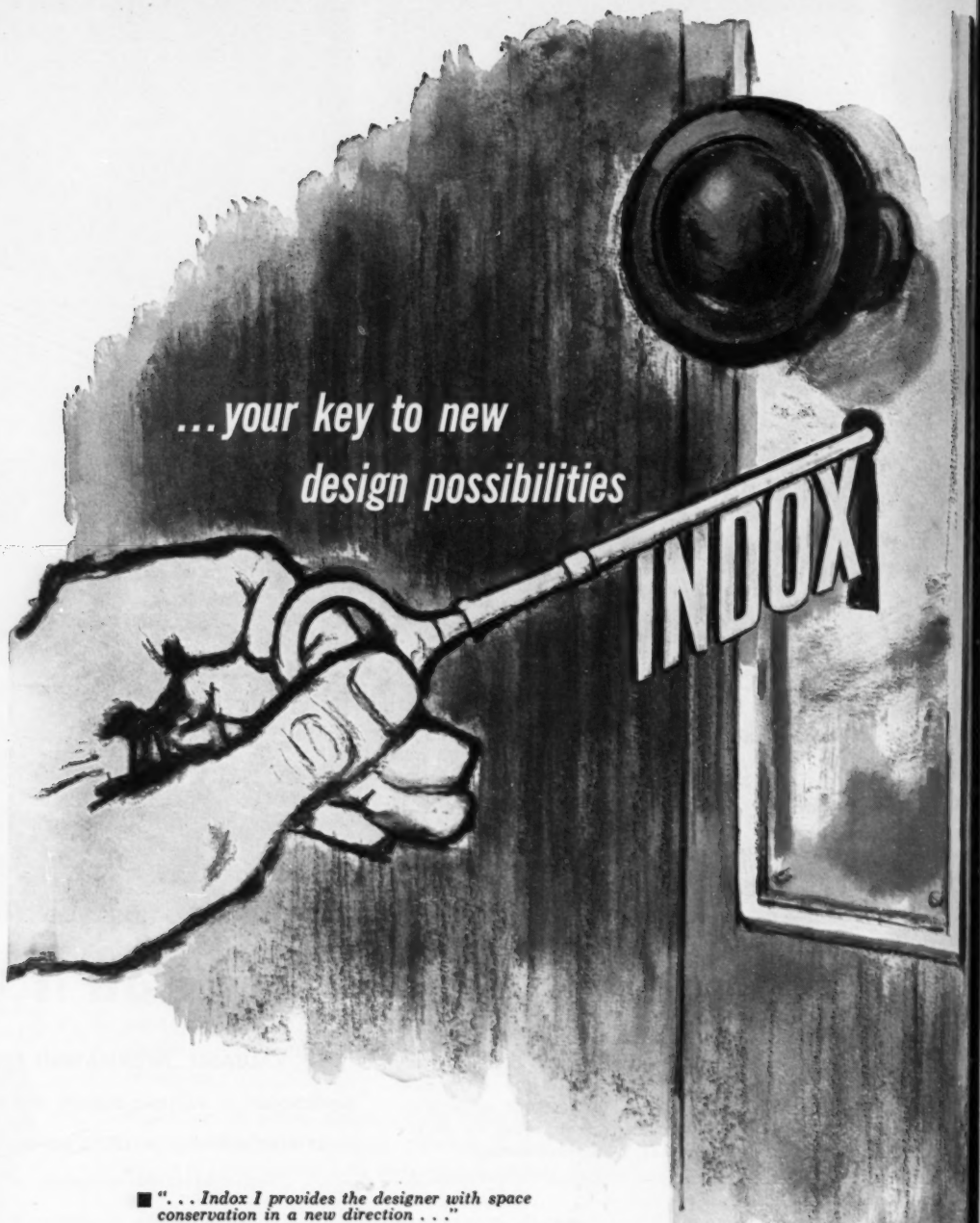
FOR MORE INFORMATION CIRCLE 10 ON PAGE 48



■ *". . . Indox I provides the designer with space conservation in a new direction . . ."*

■ *". . . Indox I shows exceptional promise for use in traveling wave tubes . . ."*

■ *". . . The high coercive force of Indox I permits both, or all, of the poles to be located on one surface of the magnet, so pole pieces can be eliminated . . ."*

■ *". . . Indox I magnets can be placed behind decorative coverings without an excessive loss in holding force—a significant design feature when equipment styling is important . . ."*

■ *". . . The high-temperature coefficient of Indox I opens a completely new field for permanent magnets . . ."*

from "Applied Magnetics"

FOR MORE INFORMATION CIRCLE 5 ON PAGE 48

CERAMIC MAGNETS

If you use permanent magnets, you should investigate the advantages of Indox I . . . the most significant permanent magnet development since the introduction of Alnico!

Indox I opens new and wider horizons of design possibilities. The applications listed below are only some of the more promising.

Smaller size . . . a longer effective life . . . lighter weight . . . savings in cost . . . improved performance . . . are just a few of the benefits already reported by users of this ceramic magnet.

Indox I is *not* a substitute for the magnetically stronger magnets such as Alnico. Instead, it extends the field of application for magnets . . . permitting design changes not always possible with Alnico.

Investigate the advantages Indox I may hold for *your* product. Our design and application engineers will be glad to help. And, because we make *all* types of permanent magnet materials, you can be sure our recommendations will be for that magnet material which will do the best job in your product. For prompt recommendations, without cost or obligation, call or write to Valparaiso today!

These special properties of Indox I:

1. No critical materials
2. High coercive force
3. Magnetization before assembly
4. High resistivity
5. Low specific gravity
6. Cost advantage
7. High potential energy
8. Low incremental permeability

. . . offer significant advantages in these applications:

ELECTRONIC
*TV focuser (1, 2, 5, 6)
Traveling wave tube (2, 3, 5)
*Loud-speakers (1, 2)

HOLDING (1, 3, 6, 7)
*Cabinet latches
*Can openers
*Holding assemblies (flashlights, fishing poles)
Door closers (refrigerators)
Conveyors (automation)
*Toys and novelties

POLARIZING (2, 4, 8)
Sonar
Magnetostriction cleaning
homogenizing
ultrasonics

ELECTRO-MECHANICAL
*Synchronous drives (1, 2, 6, 7)
Motors
d-c fields (2, 6)
a-c rotors (1, 3, 6, 7)

MISCELLANEOUS
*Arc blowout (2, 4)
*Temperature control

Note: The numbers following each application, or group of applications, identify those properties of Indox I that make it particularly well-suited to that product.

**Indox I magnets are currently being produced for these applications.*

ALNICO
Conventional-type television focuser used three Alnico magnets . . . as shown to right.

INDOX I
Shaded area shows ring type magnet . . . with simpler mounting. There are savings in space and weight.

ALNICO
Note depth of conventionally designed magnet drive unit.

INDOX I
Note *shorter* length of drive unit made of Indox I . . . which also is lighter.

Here's "Applied Magnetics" (Vol. 4, No. 3) which gives you detailed information on the design and application of Indox I Ceramic Permanent Magnets. Use this coupon to ask for your copy:

The Indiana Steel Products Company
Dept. Q-12
Valparaiso, Indiana

World's Largest Manufacturer of Permanent Magnets

Please send "Applied Magnetics" (Vol. 4, No. 3).

name_____

company_____

address_____

city_____ zone____ state_____

INDIANA PERMANENT MAGNETS

FOR MORE INFORMATION CIRCLE 5 ON PAGE 48

Increased Metal Fatigue Resistance

Any development that increases metal fatigue resistance is always happy news. Rhodex -CS- reputedly does that (the -CS- is for compressively stressed). The new rhodium plating process is said also to produce compressively stressed deposits, and to eliminate the curling, cracking, and peeling common in conventional rhodium electroplate. The development is of special interest to those who have a high reject incidence of rhodium plated components caused by the metal's high tensile stress characteristics. Illustrated is a test in which a Rhodex -CS- processed sample and a conventionally treated one were immersed in a solvent. The latter disintegrated into small crystalline flakes and the edges curled away from the base metal, demonstrating its inherent high tensile stress. The Rhodex -CS- sample showed a continuous electroplated film remaining, the edges curling toward the base metal, indicating that the sample was indeed under compressive stress.

Sel-Rex Precious Metals, Inc., Belleville, New Jersey.

For more data circle 22 on page 48.

Replaces Noble Metals

Kennametal K501 is a platinum bonded tungsten carbide reputedly as capable as the noble metals of withstanding severe corrosive and abrasive conditions—and is cheaper. Typical applications: seal rings that can be used in handling fuming nitric acid, bushings, and metering orifices. Special parts for the chemical industry have been fabricated of the stuff.

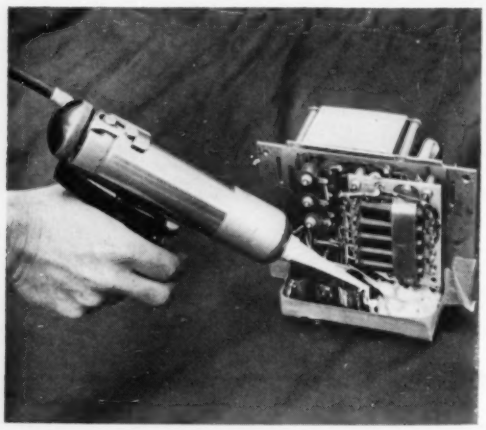
Kennametals Inc., Latrobe, Pa.

For more data circle 23 on page 48.

Floating Dollar Savers

Evaporation losses annually rob industry of millions of dollars; much could be saved through preventive measures. Mini-Vaps is a newly announced solution. Made of expanded polyethylene, Mini-Vaps are miniature floats containing thousands of tiny air cells for buoyancy and light weight. They have the outstanding chemical and solvent resistance of polyethylene, and in roughest use, cannot be punctured or broken. Surface contours of the floats provide for extensive interlocking and clustering at the surface of volatile solutions. They can be used on any tanked-fluid surface. American Agile Corp., P.O.Box 168, Bedford, Ohio.

For more data circle 20 on page 48.



Silicone Potting

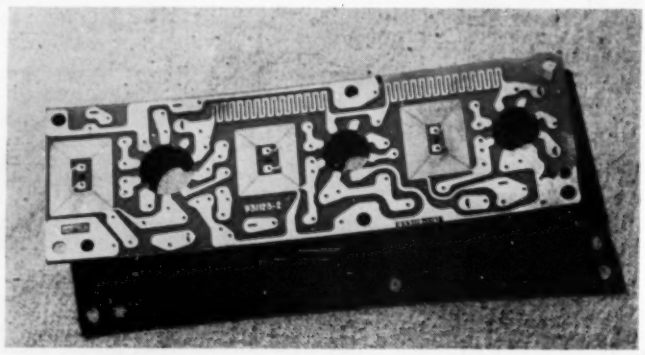
Using a new silicone rubber that cures at room temperature, engineers at Northrop Aircraft have developed a quick, easy, and almost foolproof guarantee of top performance for vital high impedance circuits. After electronic panels in the circuits are packed with resistors, capacitors, transistors, and other gear designed to record or transmit information during flight, the panels are coated with Silastic RTV, at room temperature curing silicone rubber. According to Northrop designers a single coating of the silicone rubber: 1. cushions vibration at low temperature, 2. provides maximum moisture resistance, 3. improves all the electrical properties of the panel, especially surface resistivity, and 4. protects the assemblies from possible rough handling.

Another important advantage of the material is the excellent ease of inspecting individual components after assembly. The silicone rubber is simply slit open exposing the unit for easy removal. After the component is replaced, the slit is patched with the same room temperature curing silicone rubber. Application is with a Semco gun.

Cold Punching Laminate

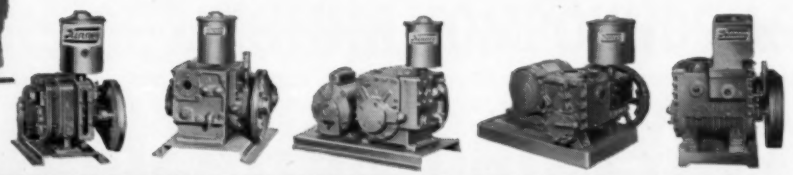
Cold punching and cold shearing, designated P-25, a new paper-base phenolic laminate that punches clean and sharp at room temperature, eliminates hot punching shrinkage allowances and need for heating equipment. It has high insulation resistance and low dielectric loss at high frequencies—even in extreme humidity. P-25 is especially recommended for copper clad laminates used in printing circuitry. The developer is Synthane Corp., Oaks Pa.

For more data circle 21 on page 48.

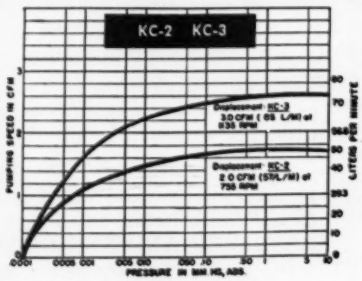


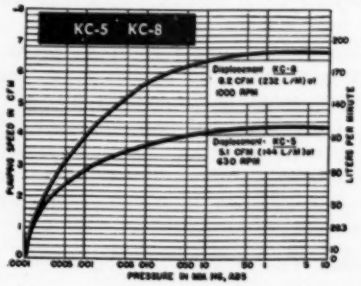
The facts speak for themselves! We rest our case!!

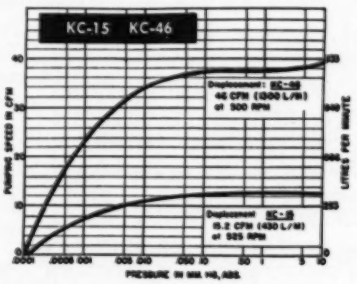
KINNEY COMPOUND HIGH VACUUM PUMPS



SPECIFICATIONS	MODEL KC-2	MODEL KC-3	MODEL KC-5	MODEL KC-8	MODEL KC-15	MODEL KC-46
Free Air Displacement . . .	2.0 CFM	3.0 CFM	5.1 CFM	8.2 CFM	15.2 CFM	46.0 CFM
Free Air Displacement . . .	56.5 Liters/min.	85.0 Liters/min.	144. Liters/min.	232. Liters/min.	430 Liters/min.	1300 Liters/min.
Free Air Displacement . . .	.95 Liters/sec.	1.41 Liters/sec.	2.4 Liters/sec.	3.9 Liters/sec.	7.2 Liters/sec.	21.7 Liters/sec.
RPM	755	1135	630	1000	525	500
Motor H.P.	¼	⅓	⅓	½	1	3
Motor RPM (syn.)	1800	1800	1800	1800	1800	1800
Oil Capacity	6 oz.	6 oz.	1⅓ pt.	1⅓ pt.	2 qt.	1 gal.
Shaft Diam.	¾"	¾"	¾"	¾"	¾"	1⅛"
Inlet Connection	¾" Screwed	¾" Screwed	1" Screwed	1" Screwed	2" Screwed	3" Screwed
Outlet Connection	None	¾" Screwed	1" Screwed	1" Screwed	1¼" Screwed	1½" Screwed
Net Weight, Complete . . .	70 lb.	78 lb.	140 lb.	148 lb.	300 lb.	585 lb.







SUMMATION

- Reliable High Vacuum (Cam and piston displacement)
- Rapid Recovery of Vacuum
- Simple to Maintain
- Dynamically Balanced
- Standard Small Motors
- Gas Ballasted (optional)
- Economical
- Dependable
- Small, Compact Design

VERDICT

Your verdict will be FAVORABLE when you review all the facts. Request Bulletin 403 for additional data or contact one of our competently staffed district offices in Baltimore, Chicago (LaGrange), Cleveland, Los Angeles, New York, Philadelphia, San Francisco, or St. Louis.

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INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N.Y.

• PLEASE SEND BULLETIN 403 giving complete data on Kinney Compound Pumps
Our vacuum problem involves _____

Name _____
Company _____
Street _____
City _____ State _____

FOR MORE INFORMATION CIRCLE 12 ON PAGE 48

Letters

Help Wanted

We are interested in securing a circuit diagram and parts specification necessary to build a pulse generator with approximately the following characteristics:

- pulse rise & fall time: each .02microsec
- pulse height range: 100millivolts
- pulse frequency: 60cy

We desire to use this equipment in testing and servicing our scintillation gamma ray spectrometer. Any help you can give us will be much appreciated.

Chas. S. Morris
DEPARTMENT OF PHYSICS
MANCHESTER COLLEGE
NORTH MANCHESTER, IND.

If any of our readers can help Mr. Morris, please write to him directly at the address given.

Rebuttal

In reference to your editorial in the November issue of RESEARCH & ENGINEERING, I am submitting information which explains my position in regard to a formal organization of human engineers and the possibility of it "Taking Human Engineering Away From Us Humans". (Mr. Peters recommended the formation of a scientific society which would integrate the various human engineering disciplines.)

There is a vast quantity of basic research currently being produced in the field of human engineering. However, much of it remains in local technical reports of limited distribution. As you suggest, certainly more of this research could be developed into readable and informative articles of general interest and published in currently available technical journals. However, much of this research is not of general interest, although it is of considerable importance to those human engineers doing basic research in the field.

The publication of such basic research results, although of limited appeal, would gradually build a storehouse of information which would be gradually integrated and from which emergent concepts could be developed. It is from these concepts that general principles are formulated and find expression in new textbooks. With improved texts, colleges and universities could teach improved courses in human engineering oriented toward the more applied aspects of this adjunct to the engineering sciences. The point is this: there is a need for some means of gathering, editing, and making available to human engineers the research results which are not of general interest but upon which the foundations of this new science must rest. One thing should be emphasized. The specialists from the various disciplines who work in the field of human engineering are not attempting to do the work of any engineer. They are merely attempting to aid the engineer in his task of securing optimum design in situations involving the human variable.

These specialists are concerned only with supplying basic research data concerning man-machine interaction, developing basic human engineering concepts, preparing recommendations for engineers or serving as consultants to project engineers. The use of such specialists is but a reflection of the increasing use of a team approach to the complex problems presented to us in this complex age of rapid technological advances.

Agreed: Too Many Societies

I am in complete agreement with your editorial comment that a formal organization of human engineers would only add one more organization to a seemingly endless array of American, National, International, and State societies, associations, clubs, groups, lodges, chapters, etc. But, what means of communication are there between the workers in this field? Only mechanical engineers can join the ASME, only those with certain minimum education and experience in the field of psychology can join the American Psychological Association, and so with each scientific discipline represented is the human engineering field. Certainly, each worker wants to retain his identification with his primary field, but there must be some means of unifying the effort and facilitating communications between those workers actively engaged in human engineering. This needs a formal organization of human engineers.

Such an organization would have these additional advantages: (1) It could coordinate the various specialized technical and professional organizations interested in human engineering. Thus, there would be less duplication of effort or working at cross purposes. (2.) It could promote the teaching of human engineering concepts by improving relations with educational institutions and providing recommendations concerning the place of human engineering training in technical and professional curricula. (3.) It could aid in developing long range research plans for the advancement of human engineering practices. Greater coordination might be achieved in basic research between the long range efforts of government agencies, educational institutions, and even private industry. Important research projects might even be sponsored under such an organization. Thus, such an organization does have great merit.

George A. Peters
PICATINNY ARSENAL

Editor's Note: Since Mr. Peters' thoughtful rebuttal to the November editorial was received, another long letter supporting his original proposal has arrived—too late for publication in this issue. The Editor's reply to these and any other communications on the subject of the proposed Society of Human Engineers and overspecialization will be carried in the next issue.

More on International Research

Seattle, Washington

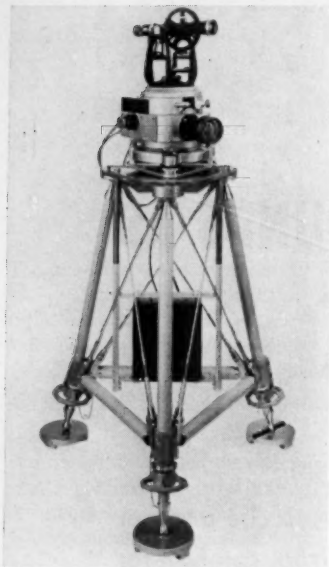
In reference to your editorial on International Research in the October issue of RESEARCH AND ENGINEERING, I am wondering if you are aware of the activities of the European Office of ARDC. One of the prime functions of this office is to negotiate research activities in Europe by European scientists for American military organizations and industrial concerns.

This office is located in the Shell Building, 47 Rue Cantersteen, Brussels, and is under the direction of Don Flickinger, General, U. S. A. F.

Arthur T. Snyder

Editor's Note: Thanks for letting us and our readers know about the activities of the Air Research and Development Command. However, this group could not be expected to place R/D contracts in Europe for work unrelated to the defense effort. According to Dr. Jesse E. Hobson, former director of Stanford Research Institute who proposed the international research placement group, progress on both sides of the Atlantic is being made in setting up such an organization.

YARDSTICKS



Aligns Gyroscopes

An Azimuth Alignment Theodolite, permitting alignment of gyroscopes within an accuracy of 2 seconds of arc, has been developed by the Engineering and Optical Div., Perkins-Elmer Corp., Norwalk, Conn. Precision gyroscopes control the path of planes, ships, guided missiles and the like. The instrument automatically detects discrepancies in the alignment of a precision gyroscope by continuous observation of the reflections from a mirror mounted on the monitored unit. Any such discrepancies produce error signals in the theodolite which are applied, automatically or manually, as corrective signals to the drive elements of the gyroscope. The, theodolite consists mainly of optical, mount, and electronic components. The instrument is capable of accuracies within 2 seconds of arc.

For more data circle 32 on page 48.

Measures Thin Films

The effective ranges of interferometry and other techniques for measuring molecular dimensions are limited to 1000 Angstroms. And though electron microscopes allow lower image resolution, it is necessary to use indirect shadow techniques in measuring thickness. The Quantum Ellipsometer is a polarizing spectrometer that can measure directly the thickness of films from several to many hundred Angstroms. Its use is therefore indicated in fields where very thin films are to be examined —lubricants, surface coatings, adhesives.

For more data circle 37 on page 48.

Scope with a Memory

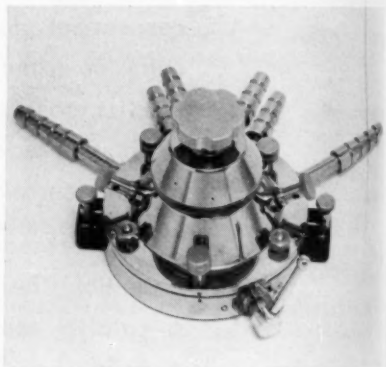
Another mechanism taking unto itself the characteristics of the human machine is the Memo-Scope 103. Basically an oscilloscope, the device has the added feature of information persistence; capturing and retaining any number of traces indefinitely. The traces are held at a constant intensity until intentionally erased, are readily visible in a brightly lighted laboratory, and may be easily photographed. Available in portable and rack-mounted models from Hughes Products, International Airport Station, Los Angeles 45, Calif.

For more data circle 31 on page 48.

Micro-Second Meter

A time interval meter designed for precise measurement of time between two events occurring in the range of 10 micro-seconds to 1 second, is designated the 250A. Optional features include extension to 10 or 100,000 seconds. Accuracy is ±10 microseconds. The measurement interval may be started and stopped by independent or common voltages representing optical, mechanical or electrical events. Typical applications: ballistics measurements, relay timing, photographic timing, testing of mechanical and electro-mechanical timing devices etc. Computer Measurements Corp., 5528 Vineland Ave., N. Hollywood, Calif.

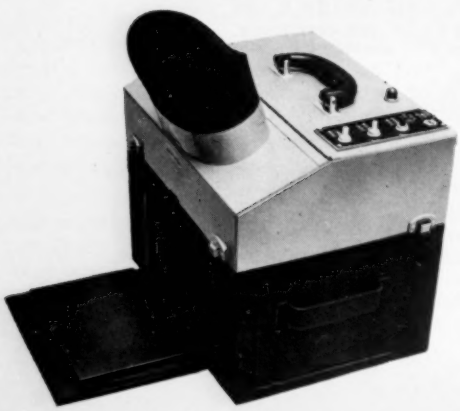
For more data circle 34 on page 48.



Looks into Metals

A new vacuum heating stage for studying metal micro-structures at temperatures up to 1100° C., has been announced. It has particularly applicability in the fields of transformations, recrystallization, grain growth, and other areas of metallurgical research. A special 40X objective with an extra-long working distance of 5-8 mm is available to allow observations and photographs at magnifications up to 800X. After any given temperature has been reached, argon gas may be introduced as a quench and the resulting structural changes in the sample observed. The vacuum heating stage can be used with any metallurgical microscope of the inverted type. Unitron Instrument Division of United Scientific Co., 204 Milk Street, Boston 9, Mass.

For more data circle 36 on page 48.



Glow Know

More than 3000 substances may be activated by ultra-violet energy to emit their own unique glow of fluorescence, can thus be identified, compared, or inspected. A new fluorescence analysis cabinet for rapid, positive identification under ultraviolet light, is being introduced by Ultra-Violet Products, Inc., of San Gabriel, Calif. Compact and self-contained, the unit can be used for in-the-field or laboratory analysis; it contains both short- and long-wave ultraviolet lamps, and white light.

For more data circle 33 on page 48.

SO YOU'RE GOING TO MAKE A SPEECH

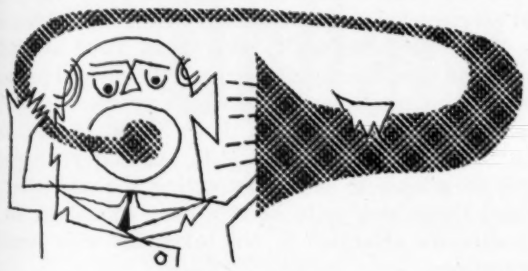
(*Continued from page 15*)

tent and its form. The triumph is an optimistic name for the event; half the battle is in the method of staging and the speaker's own general demeanor.

The Tools of Successful Speaking

The first tool is so obvious that it should hardly be worth mentioning—but it is. It is simply pronunciation. Nothing is so distracting and uninspiring in an educated group as mispronunciation of reasonably common words. And, closely related, is bad enunciation.

One of the best ways to combat bad pronunciation habits is to listen to yourself. For instance, try recording this paragraph, taken, as are those that follow, from the Stokes-Carpenter book-record combination, "A Training Course in Effective Speaking" (Funk and Wagnalls):



Test Paragraph

"For the economic facts of government, it is mandatory to consult the Library of Congress. Look in a book titled 'Report of the Bureau of Finance'. In the second column to the right, you'll find the status of every processing executive. You'll soon see where your money is being distributed."

Almost every word in that paragraph is frequently mispronounced. How did you pronounce the word "government"? Was the letter "n" pronounced or did you say "goverment"? Did you cay "Congress" or "Congriss"? "Library" or "libary"? "Your or "yer"?

It isn't so important to have your pronunciation entirely accurate in the precious sense—but sloppy enunciation is hard to understand and detracts importantly from the impression you want to create.

It's not necessary to be an actor to be a good speaker, and the old platform gestures are distinctly out of style. The underlying principle, however, is just as sound today as it was in elocution class. The accurate expression of *attitudes* while speaking is an important help in getting across what the speaker really means. The fact that these mechanical aids have been supplanted by a subtler form in no way invalidates their intent.

But the subtle method doesn't always work. For instance, sometimes the speaker in trying to convey conviction just sounds angry. The audience is confused and out of tune with the speaker.

Here's another place to bring in the recording machine —and a sympathetic wife or colleague. Read and record the following test paragraph several times, each time trying to express: (1) conviction; (2) sympathy; (3) humor; (4) deliberation; (5) enthusiasm; (6) drama.

Test Paragraph

"When the Congress was arguing about our budget for the coming fiscal year, I decided to find out, if possible, just what it was going to mean to my family. So I sent to the Census Bureau for a lot of figures, and sat down to study."

Now, listen closely to your recordings. Does your voice properly convey the attitude you intended? Ask someone else to guess what attitude you intended. Practice this exercise until you are sure that each attitude gets across.

Use of the Pause

The simplest but most effective tool of the experienced speaker is the *pause*. The dub either ignores the pause by running along like a freight train, or misuses it by filling it with "ohs" and "uhs". Intelligent use of the pause acts very much like the use of white space in an advertisement —it emphasizes what you want to say.

The following test paragraph will help you to learn to use the pause effectively.

Test Paragraph

"Great moments in history/are many./ If you had the opportunity to choose,/ at which ones would you have liked to be present?/ Might one have been when a tired president once said://'Four-score and seven years ago . . ."/ Yes, that would have been an occasion./ Or perhaps you might like to have been present on the night in 1776/ when a light flashed forth/ from an old North Church. /'Those were times to stir men's souls./ Perhaps to see courage thrills you most./ Then how about this one:/ Damn the torpedoes, full speed ahead.'// 'Damn the torpedoes, full speed ahead.'/ Yes, ladies and gentlemen,// history still lives."

There are two kinds of pauses: the natural pause and the pause for meaning. In the paragraph above, one diagonal line (/) indicates a natural pause; two diagonal lines (//) indicate a pause for meaning. Read the paragraph aloud, observing all pauses as marked. Reread it until you can present it easily, with full use of pauses for variety and emphasis.

The use of the pause to give special emphasis to an important highlight of your speech can be very effective. Read the paragraph again, this time placing deliberate emphasis on the phrase, "history still lives". To do this, you must begin to slow down a sentence or two before the important point. When you arrive at the point to emphasize, stop. Then slowly and deliberately drive it home.

Beating the Monotone

One of the most annoying symptoms of bad speaking, prevalent in the adult world and in the elementary school auditorium, is the monotone. Technically, this is simply failure to use *pitch*—the ups and downs of your voice—to help retain interest in your speech. Unless you act on "Dragnet", you don't talk in a monotone in your everyday life, but some of the most animated conversationalists retreat into a monotone when they are faced with an audience.

First thing to do is to prove to yourself that your voice has *pitch*. Speak the word "one", then say "two" on a slightly lower pitch. Continue saying numbers in a descending pitch until the result is no longer suitable in conversation. Then do the same thing starting with the initial tone and ascending the scale.

The total of the number of notes above and below your initial "one" indicates the range of your speech. Actors and singers need a very wide range; all you need to do is use the range you've got.

To illustrate the importance of varying inflections, say the following three sentences:

Well, what are you going to do?
Well, it finally happened.
Well, go on with your point.

Note how it is necessary to speak the word "well" in three different ways. In the first sentence, a rising inflection is used; in the second, a falling inflection; in the third, a level inflection. The sense of all three would be weakened without the proper inflection.

Another tool of the experienced speaker is *tempo*. We've seen how he varies it through the use of pauses.

But most importantly, he controls the tempo and doesn't let it control him. Commonest error is speaking too fast, usually the product of nervousness. It's always safe to consciously slow down, just as it's better to overexpose rather than underexpose a negative.

A good general rule is to gauge your speed according to the size of your audience—the larger the audience, the slower the speed.

One of the problems in teaching children to read is to get them to read in groups of words rather than in individual words. Of course, such an overall view of the paragraph is the key to understanding. This same principle applies in public speaking.

Inexperienced speakers, when reading a speech, often become so fascinated with each individual word that they forget the meaning of the text. The key, not only to delivery but to remembering what you're going to say, is to *deal in thoughts and ideas* instead of specific words.

How to Ready the Text

All right, let's assume you've taken your lessons and improved your delivery. Now you're facing an actual speaking date. What are the important things to do to get your manuscript in workable order?

One business executive—the chairman of a large insurance company—is perfectly honest about it. He says: "I pick brains. When I must make a speech, I ask a number of my friends and associates to write out for me what they would say on the assigned subject. These I take home and ponder. Then I confound my helpers by writing a completely new speech, but their thoughts are a stimulus."

Another good rule is to keep it short. There are few speeches that have been made in this world that could not have been improved by cutting. You need only yourself as a witness to convince you that it is much easier to keep an audience interested for 15 minutes than it is for an hour. And, quite frankly, the fact that the world's greatest leaders manage to deal with the most complicated subjects in thirty minutes leaves the rest of us with little excuse for taking longer.

One of the worst insults to an audience is the speaker who is obviously only barely familiar with what he plans to say. It's not necessary to memorize it or to read it, word for word. If it's organized into thoughts, prepared in convenient form, and has been read over a half a dozen times, it won't be too difficult to deliver convincingly.

Some people prefer notes, and some prefer a typewritten copy. In either case, triple-space and use type consistent with the quality of your vision. Never use onion skin or high quality bond paper because they crackle and are particularly distracting if a microphone is used.

A particularly good trick is to mark up your manuscript with pause and emphasis marks. Use a single diagonal line for a short pause, and a double or triple line for longer pauses. Use single and double underlines for emphasis. And use dotted lines to indicate a slowdown. Most experienced speakers use some such system, and after marking their own speech find themselves following the markings almost without referring to them.

The Triumph!

Whether this subhead is accurate will depend not only upon how effectively the speaker has mastered his tools and prepared his manuscript, but how carefully he manages his staging.

In the first place, make sure you know the kind of audience you are talking to. Thomas R. Reid, as Vice-President of Human Relations of McCormick & Company, said: "Public speaking is no more than private speaking multiplied . . . Get advance information on the size, type, and interests of your audience . . . Then spend the time during luncheon, dinner, or introduction re-evaluating it by actual observation . . ."

It's almost as important to know the conditions under which you're going to speak as the type of audience. How large a hall will you be in? Will you have a microphone available? Will you have a podium, or will you have to shuffle your own papers? Usually, if you check beforehand, you can control the conditions and get what is best.

Most experienced speakers neither drink nor eat too much before their "performance". Food takes blood away from the brain and temporarily unsharpens the mental processes. Most after-dinner speakers reverse the process.

When you get on your feet, don't fidget. If you find it difficult to stand straight and still, lean on your podium or perch on a table to avoid distracting the audience. The important thing here is to be relatively immobile, so that your audience's attention is not taken up with watching your gyrations.

Your hands can be useful in emphasizing points, but if you insist on using them to shuffle your papers, keep them in your pockets.

Watch "Ohing" and "Uhing"

Next to fidgeting, the worst delivery fault is "ohing" and "uhing". Even more important than confidence in conquering this nervous habit is familiarity with your material. The "oh" and the "uh" is usually the mark of the slow thinker who has not properly done his lessons for the speech.

But what happens when you sense that you don't have your audience, for all these preparations? Harry A. Bullis, board chairman of General Mills, has a piece of advice here: "If your speech is not going well, use some dramatic device, such as a pause, a story, a change of pace, or unusual use of voice inflection. . . if your text is at fault, extemporize, if this is possible. . . The first five minutes usually determines the success or failure of a speech."

An almost sure device for getting the audience's attention back on the track is the fake pause. Just stop abruptly for a minute, and watch the audience snap to attention. Then go on as if nothing had happened.

Neither the tools, the text, nor the staging of the event can assure a real triumph, any more than all the speech training in the world is going to turn the average technical man into a Demosthenes—but these few hints, taken just as seriously as he takes the multiplication table, will help him do a more effective job of projecting himself. And this will be good for him and for his company. END

Saving Drafting Dollars

Suggestion: turn-in frills and furbelows for tailored necessities.

One dominant theme in current discussions of industrial problems is the skilled-personnel shortage. The condition can at least be alleviated by making the most efficient use of what is available. And this is as true in drafting sections as in any other.

J. H. Bergen, standards administrator for the American Machine and Foundry Company, reports savings in drafting time up to 55% by virtue of an 11-point program resulting from studies in the Greenwhich, Connecticut plant.

The studies showed that a group leader spends 43% of his day gathering information, 27% giving it to others, and the remaining 30% in small talk, smoking, hand-washing, pencil sharpening, memo reading, and similarly vital functions.

The checker spends 13% of his time acquiring information, 62% checking, and 25% unproductively. Draftsmen acquired information for 23% of their time, spent 53% working on layouts and details, and 24% in nonproductive activity.

The average percentages worked out to a fairly good productive-nonproductive time split of 73% to 27%. AMF did not seek to better the time split, sought rather to make better use of the existing productive portion.

One action taken was the addition of clerical help to act as legmen for the more expensive board people. The clerks get catalogues and supplies, sharpen pencils, and generally make themselves useful to the designers and detailers. Overall efficiency of the drafting section improved considerably even though the clerks were sometimes used inefficiently; the wide wage differential making the difference.

Continued study of the drafting operation showed that design engineering costs could be broken down into about five items: 15% of cost was spent preparing to do a job; 45% on design and detailing; 28% on checking, 4% to release the completed work; and 8% were miscellaneous costs. It was found, further, that as much as 38% of the drawings produced on development-type work were obsoleted before the item went into production.

Little else could be done to improve the basic efficiency of the men, but anything that could be done to remove some of the unessential work from the drawings would reduce their time cost: 4.5 hours per square foot. More time could be spent on functional design than on frills and the percentage of void drawings would be reduced. The 11-point program for simplified drafting was here introduced.

The 11-Point Program

***Use description to reduce drawing.** Words can often be used in place of drawings without sacrificing clarity. For example, a description of a cube, which has height, width, and depth, is entirely understandable since the reader automatically forms a mental picture from the description. A drawing is not required.

***Use description to eliminate projected views.** Using the term **diameter** on a side view can frequently eliminate the necessity for an end view. Further, by describing material (e.g., hex stock in the title block), an end view for special hex-headed stud can be eliminated.

***Omit elaborate pictorial or repetitive details.** Most draftsmen consider it a cardinal sin to duplicate dimensions without noting the duplicates as reference dimensions. However, by standard drafting practice, draftsmen draw three views and show even the most minor item in all of them. This makes for confusion. Where the simplified practices are followed, dotted lines indicating hidden surface might be eliminated in several views. The drawing then becomes less confusing to the man in the shop.

***Use key legends to indicate hardware.** Outlins of screws, nuts, and bolts, are used only where it is necessary to show the position of a particular piece. Draftsmen sometimes go to artistic excess showing not only a round-head screw, but also the screwdriver slot in the screw's head, the socket in the hex-head cap screws, and so on. A key list of hardware parts in the lower right-hand corner of the drawing is used in place of repetitive details. The advantages of having all such information organized in one place are obvious.

***Use dotted lines only to aid clarification.** Under conventional drafting practice it would be necessary, in almost any case, to show a drilled or tapped hole: one view to show the centerline of the hole, and the hole itself fairly close to scale; the other to show the hole's depth. Both views involve dotted lines. But the lines and the extra view can be eliminated by merely adding a note specifying the hole's size and depth.

***Eliminate most cross-hatching.** It need be used only where it will aid clarification by emphasizing parts that might otherwise be difficult to see. Standard drafting practices include several symbols for various materials, but there is no effort made to indicate particular type of material within a general range. For example, one symbol is used to represent all steel, no effort being made to indicate whether the steel is 1010 or 4160. And yet the important point is not that a part is made of steel, but that it is made

of a particular steel. The same argument holds for many other materials.

Analysis of the use of cross-hatching shows that it is generally used on assembly drawings to show how parts go together. But a man assembling the parts need not know the material of a part, but only how it fits into the assembly.

***Use symbols to indicate various hole sizes.** Besides eliminating human and mechanical errors, time is saved here. The need for drawing the hole can be eliminated altogether by using a symbol, such as *A*, *B*, or *C*, where the center-lines for each hole cross. Corresponding notes, identified with an *A*, *B*, or *C*, give the required information with no confusion whatever.

***Avoid hand lettering.** Typing notes not only reduces misspelling and illegibility, but also provides information in a standard form. A glue-backed transparent paper applique is excellent for this purpose.

When a draftsman completes a drawing, he gets a checker's print and writes on it the notes that apply to the drawing. The checker checks print and notes, gives them to a typist who types the information on the applique. Detailer check again, and apply the applique to the tracing. It is a time-consuming procedure but no more so than hand-lettering; and it saves the more expensive time of the letterer.

***Avoid the use of arrowheads.** If a draftsman is at all careful in preparing them they take considerable time. If he is not careful, they may fall short of or exceed the extension line. In either case sloppy work is expensive but doesn't tell a story, careful work is time consuming. By eliminating arrowheads completely, or by using a dot in their stead, the same information is conveyed.

***Use datum lines for dimensions.** In using datum line dimensions, a zero is shown as a starting dimension, and the actual dimension is placed between zero and an extension line directly above the datum extension line. Drawings thus prepared need no dimension lines at all, are cleaner in appearance and less confusing.

***Use freehand sketches wherever possible, rather than drawings made with a machine or straightedge.** But freehand methods are avoided on any sheet larger than 17x22.

Results and Thank you's

Mr. Bergen noted improved efficiency to 55% but cautions that the successful application of these practices requires that reliance be put on the people making the drawings to use their common sense in adopting them as they see fit. They are suggestions and not commands.

AMF received thousands of requests and acknowledgments for the simplified drafting recommendations. One recipient wrote:

"Dear Sir:

Your simplified Drafting stinks. Sloppy drawings for sloppy work. I don't suppose you wear a necktie—takes too long to tie it, no use to shine your shoes—costs too much and takes too long; calendar pin-up girls on your walls at home give the same general effect as old masters; spoiling work in the shop is cheaper than a decent drawing. Teach our youngsters to be sloppy workers—forget part of workmanship—Get back on the beam—does a few bucks mean everything to you? Better spend a few hours taking stock of yourself."

"As you can see", says Mr. Bergen, "simplified drafting is a controversial subject."

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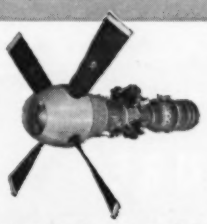

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FOR MORE INFORMATION CIRCLE 14 ON PAGE 48

TECHNICAL MANAGEMENT

(*Continued from page 2*)

him. Where assignments are made to committee members on a result of the meeting, I like to see each person's assignment spelled out. A way of doing this is for the secretary to underline the assignment as it appears in the minutes on the copy going to that individual responsible for the action. The person receiving the minutes can see his assignments at a glance. The chairman's copy should, of course, be annotated by the secretary so that it is easy for him to ask for reports on the actions to be taken.

Should the Boss be the Chairman?

It is not necessary that the highest ranking person conduct the conference or meeting. Rather, the person who has the problem or who knows what he wants to accomplish should conduct it. Often the highest ranking person is not the best qualified to conduct the meeting, and it is a mistake, in my opinion, to let him conduct it simply out of deference to his rank.

On Treating the Human Dynamo

Dr. Robert Lobstein of Los Angeles writes in answer to the question I posed in my October column as follows:

". . . I can not answer your question (how to treat the human dynamo) with a 'yes' or 'no' or a 'right' or 'wrong' . . . the 'standard' creative engineer (I do not want to use the term average), will work with his co-workers, both above and below him. These engineers have the patience and understanding . .

"Now as to the dynamic engineer who cannot work in regular hours, who cannot accept orders or give orders, he himself has to decide how to work and when to work. For this type of engineer, there is no place in a factory, in a research laboratory of an enterprise or in an engineering department. He belongs in a research institute, or better, in a university where he can work as he wishes.

"A good management will find the right solution for salaries and working hours and the results can be rewarding for both sides. But it would be a great mistake to make a laborer out of a high-level engineer with ingenuity, inventiveness, inspiration, instinct and originality."

Discussion of the Servocomp Case

Discussion still comes in on the Servocomp Case which was presented in the April and May issues of this year. The situation portrayed is so common that I have been accused of having pipelines into any number of organizations! Here lies the consolation: If you think you are fouled up, you should see some of the other organizations!

I have a reply from a person who wishes his name and company affiliation to be withheld. He is very harsh with the Research Director, saying "he could not even manage a peanut stand"! Assuming he were the Research Director, he would

• Call in the division head slated for the axe and negotiate his termination, effective at once or deferred and the terms fixed

• Call in the department head slated for the shelf as a consultant and tell him of his new status.
• Make tentative plans with the other two for allocation of personnel and assignments.
• Promptly post a notice to inform all personnel of the changes.

My correspondent's principles of management were nearly identical with those submitted by L. G. F. Jones in the column last month. I liked particularly this writer's reply to the question "What responsibilities does the man who was Division Head No. 4 have for bringing the morale factor to the attention of the Research Director?" My correspondent replies as follows: "He has the moral responsibility to display leadership and courage. (He is in a leadership post until he is officially removed). If courage requires that he walk in and provide for the security of his men (their peace of mind and productivity are part of that security), then his job calls for courage and fortitude. Neglecting his clearcut duty will not change the ultimate outcome. Everybody recognizes that he is through. He can at least step out with dignity and self respect."

Discussion of the Unenthusiastic Manager

From some of the correspondence received, it would appear that the case was not as simple as supposed. In the final preparation of copy for the printer, a change was made in wording which makes the problem somewhat ambiguous. Here is the problem again in somewhat different words.

Mr. Goff is Director of Research. Mr. Fall reports to him. Mr. Fall has three sections in his department with a total of about 20 people. There has been an organizational change which does not affect the reporting of any of the persons but does mean that there will be a cut back in technical work. Responsibility for the remaining work will be given to another department. Mr. Goff believes this other department is more competent to handle it but Mr. Fall feels that his own department is better qualified. Fall presents his reasons for feeling as he does. He advances the argument that the personnel in his department will resent being bypassed. Mr. Goff, after unsuccessfully trying to convince Fall this isn't so, tells him that the change will go into effect despite his opposition.

How does Fall proceed? How does he announce the change to his staff? Does he pass the directive along without comment? What does he say if asked how he feels about it? Does he pass it along as though he were enthusiastic about the idea and give all the reasons which Goff has given him in support of the change? How should instructions be relayed to the department in these circumstances? Can you state any guiding principles?

Discussion will follow in a later issue, but discussion to date shows many different points of view on the situation. Perhaps this case, more than any other, illustrates the value of the Case Study method since in order to come up with an answer, some assumptions must be made. The analogy to a real situation lies in the fact that one must find out these points since they are very relevant to the optimum solution of the problem. Let us hear from you!

More on Bingo Corp.

L. Pessel of Wyndmoor, Pa. writes:

"The basic problem in this case seems to be that no mechanism has yet been devised by which invention as such can be planned, scheduled or accelerated. Even if a department succeeds in obtaining individuals with a record of inventive accomplishment and in providing an environment stimulating inventive creativity, there is no certainty in timing or assuring the advent of invention.

"It must be assumed that the Research Director was aware of this fact as well as of the crucial role of invention in the completion of the project. Thus it becomes a case of faulty communication between him and Management. It might have been the better part of wisdom to introduce into his 'progress' reports a stronger emphasis on the retarding factors. While it may require considerable moral courage to sell 'retardation', the outcome of this case indicates the need for such a course."

British research groups worth studying

American industry and government could learn a great deal from the British Research Association movement, according to Dr. William Eaton, a New York City consultant. Since these cooperative R/D groups are an outgrowth of trade associations, their method of operation should be particularly interesting to trade associations in this country. Eaton was one of two American representatives at the recent conference on The Organization of Industrial Research, held at Ashridge, England. Representatives of eleven European countries and several Commonwealth nations also attended. Directors of many of the British research associations spoke at the Conference on the philosophy and modus operandi of their respective organizations.

Very few trade associations in this country sponsor any basic or applied research projects or have any cooperative laboratory facilities, according to Eaton. The few that do, such as The National Institute of Dry Cleaning, have enjoyed great benefits. The Dry Cleaning Organization has had a central research laboratory since 1927. On the other hand, American industry can go to the great R/D organizations such as the Armour and Mellon Foundations, which are virtually non-existent in Great Britain, according to Eaton.

The typical research association is a non-profit corporation with its affairs managed by a council elected by the member companies and composed mainly of the leaders of the association. The combined staff of all the British research associations is now about 4500 of whom about 1400 are college graduates or the equivalent. Subscription from member companies are normally guaranteed for several years at a time to give the necessary financial stability. Rates of subscription are determined by the members or by the council, and may be based on invested capital, number of employees, total wages, or consumption of raw materials. Sometime the payments are made through the trade association, which passes along a single sum to its associated research group.

How is Government Support Provided?

The British Government officially supports, in varying degree, the various research associations. Grants are made available primarily to encourage the formation and growth of the associations. In all cases the government grants are related to the money put up by the industry itself. In accepting this government support, the associations do not surrender their independence; there are virtually no strings attached. The government grant is simply included in total income and from an operating standpoint is indistinguishable from funds supplied by member companies. However, the government may nominate one or two experts to the association's governing council.

Won Nobel Prize in Chemistry

One outstanding result of the work of these associations is the 1952 Nobel Prize for Chemistry Award to Drs. Martin and Synge of the Wool Research Association. They developed the technique of partition chromotography and applied it to the separation of the chemical constituents of the wool fibre. The associations cooperate with the British Standards Institution to develop methods of testing for all kinds of products. For example, the Electrical Research Association provides representatives on 150 Standards Committee and has a large amount of data in connection with standardization. The work of the Cast Iron Research Association has led to the development of the now well-known nodular cast iron which has replaced steel in certain applications.

Can't Be Copied Uncritically

Because of basic differences between British and American political thought and industrial organization, Eaton stresses that the structure of the British Research Associa-

ions cannot be copied uncritically in this country. We have always avoided institutions which tend to equalize rather than to differentiate the individual members companies of any industry. The British, on the other hand have followed a different path and recently of course have nationalized several of their largest industries. It is not unexpected that the cooperative research has been less widespread here than in Britain. But the British strongly maintain that cooperative research does not eliminate competition, since the individual companies utilize the pooled research results to a widely varying extent, according to Eaton.

Pamphlet Available

For more detailed information on the British Research Associations, readers can obtain a recently issued pamphlet entitled "Combining For Research", from the Department of Scientific and Industrial Research, Charles House, 5/11 Regent Street, London, S.W. 1, England.

CRITIQUE OF IMPURE REASON

There are some things we know about computers and their limitations. Among these are: a computer can perform only operations built into it; and the operations are built-in by men. Men have limitations that can be expressed similarly: men cannot do what men cannot do.

It follows from these propositions that a computer cannot do what men cannot do—though it can do what it does much faster than men.

With these limitations in mind, one reads with perplexity an announcement carried by the Associated Press, in November, datelined Los Angeles:

> A team of scientists has proposed building an electronic brain in the hope of adding a new dimension to man's perception. The team believes that man, handicapped by a limited ability to perceive dimensions, may be unaware of the true shape of things . . . by studying the limitations of his brain, man may be able to build a computer that could peer around "the fourth dimensional corner" and translate what it finds there into a language he can understand. If that occurs "events which seem now to be unpredictable, and therefore unavoidable, might be forseeable, and the future would seem less mysterious."

Here it is that perplexity arises. For how can "new perceptions" be invented if they must yet be reduced to the familiar terms by which a thing can be known? Isn't it literally meaningless to speak of the "true shape of things" apart from our perceptions since that "shape" must yet be submitted to our perceptions?

If we assume that our perceptions are not the "true shapes", then we see only perceptions, and there can be no healing the breach. And if we assume that our perceptions are only possible *appearances* of "true shapes", then new mathematical relations might be discovered or invented, but since those new relations, too, would be perceptions, they would still, so far as we could know, not necessarily be "true shapes", but would still be mere appearances.

And finally, if we assume that our perceptions are, indeed, the "true shapes", and we are ignorant of the future, then the proposed machine could only compound our ignorance.—Sandek

BOOKS

Common Sense in Research and Development Management

BY GEORGE W. HOWARD

Reviewed by John Rivoire, Manager of Market Research, Westvaco Mineral Products Div., Food Machinery & Chemical Corp.

This thin volume is a collection of impressions on the business of running a research organization, gathered by the author during the course of a series of visits to a large number of research organizations under a Rockefeller Public Service Award.

The book summarizes observations on several categories of research management activities as actually carried out by the organizations visited or contacted by the author. These organizations appear to represent a fair cross-section, though by no means a true sample of government, university and industrial research as carried out in the United States, Canada and Europe. (Of the 82 organizations contacted, 12 were classed as university establishments, 12 were government centers, and 48 were designated industrial research units, including both company laboratories and independent research organizations). In most instances, the method was personal interview of responsible managerial personnel according to a generally defined but not formalized set of questions.

The author's impressions are gathered under a series of headings, as follows: Control of Research and Development, Selection of Personnel, Professional Development, Direction of R & D Work, Planning and Checking Progress, Management of Laboratory Finances, Internal Communications, and Auxiliary Services. Each chapter is ended by a brief summary of conclusions drawn by the author's observations on the subject. Probably few research directors will quarrel with these observations. Essentially, they restate the conclusions many research directors have reached by thinking through the nature of their jobs and responsibilities.

The chief value of this little book seems to be its unpretentious approach to an organized way of thinking about research administration. It has somewhat the nature of a preliminary report and leads the reader to expect a more complete and penetrating analysis of the problems of research management. We can be hopeful that such a comprehensive study will one day be made.

Vantage Press, Inc., 102 pages. $2.75.

A Modern Introduction to Mathematics

BY JOHN E. FREUND

Reviewed by Helen Hassler, General Electric Co., Nela Park, East Cleveland, Ohio.

One of the first and loudest complaints of many teachers and professors in our schools and universities is the inability of their pupils to think creatively and validly. There is a realization growing that a thorough understanding of the basic rules of logic is necessary to clear thinking.

"A Modern Introduction to Mathematics" is an attempt to meet this need. It is aimed at the college freshman or sophomore, with the intention of helping him get the most from his courses by way of comprehension and application.

And it succeeds admirably. It is clear, understandable to any reasonably intelligent person, and beautifully written. It takes almost nothing for granted beyond the most elementary algebraic rules —indeed the first few chapters are perhaps too elementary.

Despite the title, the book is concerned much more with mathematical logic and inference than it is with mathematical problems. The first section is given to definitions, postulates, and basic rules of logic, together with their application to algebra and geometry, with special attention to number theory. A section on pure and applied algebra, geometry, trigonometry, analytic geometry, and elementary calculus, follows. The last part of the book is devoted to symbolic logic, statistics, probability theory, etc.

None of these subjects are treated exhaustively—it would be impossible to do so in one book. However, each is carefully defined and rigorously developed from a few basic concepts. A study of any one of them should give the student and excellent background for further study. This reviewer found the chapter on elementary calculus exceptionally valuable.

Considering that the tendency in most universities is toward learning the practical aspects of mathematics, this book would scarcely serve as an adequate textbook: comparatively little space is devoted to the actual techniques of the various branches of mathematics. The author states in the preface that it should be possible for a student, with some additional outside study, to proceed to the study of calculus after taking a course based on this book. This may be correct— basic trigonometrical and geometrical relations can be understood easily once the habit of analytical thinking has been developed. Nevertheless, knowledge of the theoretical development of axioms can hardly take the place of practice in techniques of applying them, and a student who has completed a course based on "A Modern Introduction to Mathematics" would scarcely be proficient in solving mathematical problems, especially in the more advanced but still basic problems of trigonometry and analytic geometry.

Perhaps the greatest value of the book lies in the method of presentation. It is most interestingly written, with brief mention being made of the historical development of various hypotheses and formulas. Several chapters are devoted to specialized branches of mathematics and logic, such as transfinite numbers, Boolean algebra, and non-Euclidean geometry. The author suggests that these chapters are included to stimulate interest in future study, and that they may be omitted without loss of continuity. While such subjects are by no means necessary to a practical understanding of the applications of mathematics, they form a fascinating and important adjunct to the study of the laws by which mathematics has reached its present development.

It is doubtful that this book could take the place of courses in formal mathematics; but it would certainly make the study of mathematics much more interesting and easier, and it might very well persuade many students that the study of logic and mathematics is the basis for study in most, if not all, other subjects. Toward this end — the development of mathematical thought—this book is to be highly recommended.

Prentice-Hall Inc. Publishing, New York, N.Y., 536 pages, $8.00.

Determination of Organic Compounds

BY K. G. STONE

Reviewed by J. L. Sorkin

Organic analysis is made difficult because of the tremendous number of compounds formed from a relatively small group of elements, and because few reactions are known which are specific to the individual compounds. It is possible, however, by means of reactions with the proper reagents to characterize the more

reactive components of organic compounds, such as hydroxyl, carboxyl, vinyl, benzyl groups.

The author of this book has endeavored, with success, to present a text offering a variety of reactions specific to each functional group. Equally important to the student is the wide diversity of analytical procedures covered. Thus, in following the techniques described, he will, of necessity, become acquainted not only with standard gravometric and titrometric analyses but also with gasometric, instrumental, and other less frequently proposed procedures.

As a text, the book's usefulness is increased by its simple, systematic presentation, by illustrations of the apparatus, numerous literature references, and by problems at the end of each chapter.

The chapter dealing with the determination of water in organic compounds is noteworthy. This subject, of increasing industrial importance, is one as yet ignored by many similar texts. Three quantitative methods of determining water are proposed: by the formation of cuprous acetylide, by distillation, and the Karl Fischer method.

In preparing his text the author has chosen to ignore the more qualitative, though equally important, phases of organic analysis, elemental analysis, the determination of physical properties, the preparation of derivatives. The book should be particularly useful as a supplementary text in the field of organic analysis.

McGraw-Hill Book Company, Inc. New York, N.Y., (1956), 214 pages, $5.00.

RESEARCH REPORTS

Air Pollution Research

Growing nationwide concern over the problems of air pollution is reflected in a new report on current research in the field. The report, designed as an aid to engineers, public health officers, scientists, and others interested in air pollution problems, shows that 68 colleges, universities and research institutes now report that they are carrying on research in air pollution. The comparable number was 45 in 1955 and 37 in 1953.

According to Frederick S. Mallette, Secretary of the Committee on Air Pollution Controls of the ASME, the current report is the second in a series of three scheduled for publication this year. The first, published in July, provided a list of instruments and devices useful in the study of air pollution. The third will deal with air pollution control equipment of all kinds. A monthly newsletter, *Smog News*, is also published by the committee.

The current report, titled, GUIDE TO RESEARCH IN AIR POLLUTION, *may be obtained at a cost of $1.50 per copy by writing to Order Department, American Society of Mechanical Engineers, 29 West 39th St., New York 18, N.Y.*

Conference on Elastomer R/D

Technical papers presented at the fourth Army-Navy-Air Force Conference on Elastomer Research and Development in January 1956 have been published. Sixty-four reports by military researchers describe specific work with elastomers in the general areas of selection and improvement of materials, evaluation of new materials from industry and, in particular, invention and discovery of new materials to meet the needs of extreme operational conditions.

The publication, ELASTOMER RESEARCH AND DEVELOPMENT, *is available in two volumes: Volume 1, PB 121360, 152 pages, price $2.50; and Volume 2, PB 121361, 314 pages, $5.50. This and the following reports may be obtained from OTS, U.S. Department of Commerce.*

Magnesium Tests

Test methods for evaluating the quality of chemical and electro-chemical surface treatments with respect to corrosion resistance afforded by the treatments to the base metal, and the adherence between paint type coatings and the best metal afforded by surface treatments are the subject of this report. In this research, the gasometric method was the most promising for evaluation of corrosion resistance.

RESEARCH ON TREATED MAGNESIUM SURFACES, PB 121140, 187 pages, $4.75.

Magnetite Grown

Magnetite crystals were successfully grown at a rate of 0.05 mm a day with the hydrothermal process. Growth occurred in steel autoclaves containing ammonium chloride solution. Temperature at top of chamber, where the crystals grew, was 430°C and at the bottom 480°. Pressure was about 22,500 psi. Growth rate decreased with lower temperatures. Evidence showed that the growth was the outcome of a chemical process.

INVESTIGATION OF METHODS OF PRODUCING SINGLE CRYSTALS OF NON-METALLIC FERROMAGNETIC SUBSTANCES, PB 111934, 66 pages, $1.75.

Anti-Icing Manual

Research concerning design of thermal anti-icing systems for aircraft wing and tail surfaces has been compiled in manual form. This report provides methods and reference material for design of steady-state systems utilizing as the heating medium hot air flowing along inner surfaces of the skin through so-called double-skin heat exchangers.

A DESIGN MANUAL FOR THERMAL ANTI-ICING SYSTEMS, PB 121135, 302 pages, $5.50.

management affairs

Seven of the most popular articles for improving technical management published in RESEARCH & ENGINEERING in recent months have been reprinted, including five by Luis J. A. Villalon, our Management Affairs Editor. Available for 25¢ each, they are listed below.

LIMIT THEOREMS: Practical Tool for Project Evaluation

THE DIFFICULT PERSONALITY PROBLEM IN R & D

EXECUTIVE HEALTH: 14 Ways to Maintain It

HOW'S YOUR STAFF EFFICIENCY?

HOW'S YOUR ORGANIZATION QUOTIENT?

TIME MANAGEMENT FOR THE RESEARCH EXECUTIVE

Reprints of the above articles on management problems are available for twenty-five cents each. Send check or money order to RESEARCH & ENGINEERING, *77 South St., Stamford, Conn.*

THIS IS INERTIAL NAVIGATION

(*Continued from page 12*)

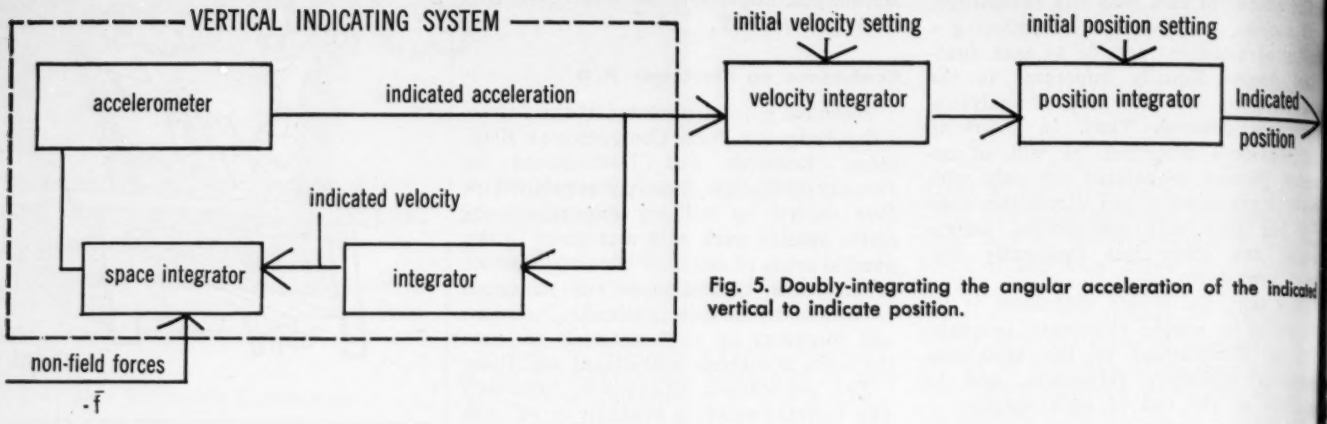


Fig. 5. Doubly-integrating the angular acceleration of the indicated vertical to indicate position.

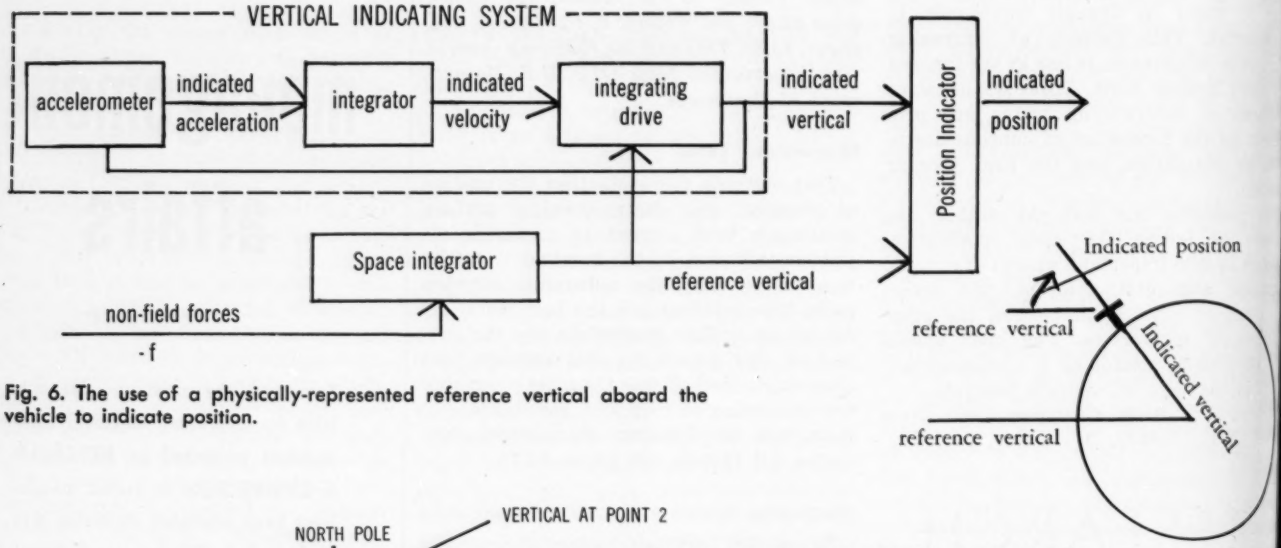


Fig. 6. The use of a physically-represented reference vertical aboard the vehicle to indicate position.

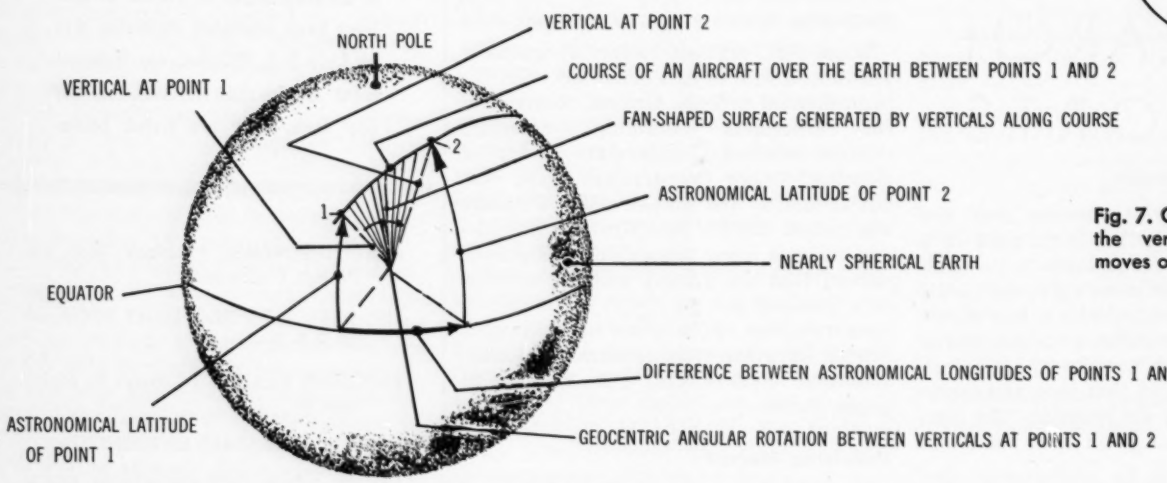


Fig. 7. Geocentric rotation of the vertical as a vehicle moves over the Earth.

Using Star Lines

Star lines, or, alternatively, gyroscope-fixed lines, are used to get the reference sides of the position angles used in navigation. The line of radiant energy from a star to the Earth is parallel to *some* vertical; the precise location of this vertical at any given time is found in the navigator's almanac. The angle between the star line and the local vertical is used to compute position relative to the reference substellar position tabulated in the almanac. Thus, star lines serve as references fixed externally to the Earth, and are said to be *fixed in inertial space* (inertial space represents the reference frames in which Newton's laws of motion are valid and are associated with the "fixed stars").

Gyroscope axes provide portable star lines, because such gyroscope references can be used within a vehicle to determine directions with respect to inertial space.[4] Thus gyroscopes provide for the basic requirement of inertial navigation references: self-contained information sources

John Hovorka received his M. S. in Physics from the University of Illinois in 1943 and is an alumnus of the war-born M. I. T. Radiation Laboratory. He is a Staff Physicist with the M. I. T. Instrumentation Laboratory, and is chiefly concerned with inertial navigation and fire control studies.

Dr. Walter Wrigley received his Sc.D. in Physics from the Massachusetts Institute of Technology in 1942; his doctoral thesis was based on some considerations of inertial navigation which are now part of the basic literature. Dr. Wrigley is Professor of Aeronautical Engineering and Educational Director of the Instrumentation Laboratory, M. I. T.

out the universe external to the vehicle. A position-indicator using the space integrator to maintain an inertial reference vertical aboard the vehicle is block-diagrammed in Fig. 6. Here the vertical indicator output is compared with the reference vertical from a space integrator*, the angle between the verticals being interpreted by the position indicator as indicated position, i.e., as either latitude or longitude, depending on which component of position is under consideration.

In Fig. 3, a different method of position indication is employed: the vertical indicating system loop is "tapped" at the space integrator input, which is proportional to the angular velocity of the indicated vertical; latitude rate, or longitude rate projected along the north-line, as the case may be. One integration of this quantity suffices to give position change, as shown in the block diagram. In Fig. 5, the same kind of vertical indicating loop is tapped at the accelerometer output level; in this case, an open-chain double integration gives position change.

New Navigation Method

Inertial navigation is a method of navigating which renders automatic the conventional navigator's responses to the unbalanced force acting on him and to his observations of Earth's rotation relative to the stars.[5] The instrumental response to these inputs is based on the use of accelerometers as force-detectors and gyros as portable inertial references. The present picture of the art appears to involve a heavy research investment in these classes of instruments. END

REFERENCES

Wrigley, W., "An Investigation of Methods Available for Indicating the Direction of the Vertical from Moving Bases," ScD Thesis, M.I.T., 1941.

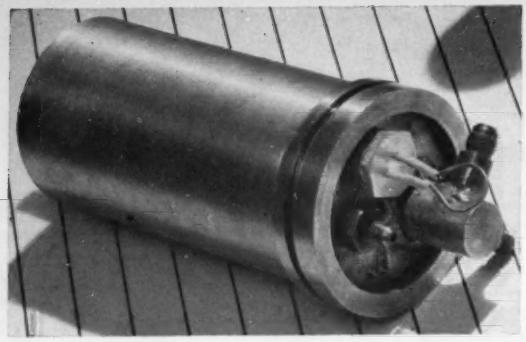
Schuler, M., "Die Störung von Pendul- und Kreiselapparaten durch die Beschleunigung der Fahrzeuges," Physicalische Zeitschrift, 24, 1923.

Wrigley, W., "Schuler Tuning Characteristics in Navigational Instruments," *Journal of the Institute of Navigation*, VII No. 2, 282, December, 1950.

Draper, C. S., Wrigley, W., and Grohe, L. R., "The Floating Integrating Gyro and Its Application to Geometrical Stabilization Problems on Moving Bases," Institute of Aeronautical Sciences S. M. F. Fund Paper No. FF-13, New York, January, 1955.

Klass, Philip J., "Inertial Navigation: Out of the Laboratory and into Missile Systems," *Aviation Week* Special Report, McGraw-Hill, New York, 1956.

*Since a space integrator is used for the reference vertical it is not necessary to use another space integrator for the local vertical, an ordinary integrating drive is sufficient.



Pre-Packaged Gas Generators

Capable of creating a known amount of gas at predictable pressures and temperatures for a given time, these pre-packaged gas generators can be supplied with a wide range of different pressure/time characteristics to suit application requirements of primary interest to aircraft and missile industries. The units are designed to provide power for: operation of turbines, pressurization of fluids and systems, actuation of pistons and expandable rings, and ignition of liquid propellants. Having no moving parts, they are unaffected by acceleration, vibration, etc. Horsepower outputs range from 0.01 to 150 and output pressures from 15 to 25,000 psi. Reliability factor approaches 100%. McCormick Selph Associates, 89 Hollister Airport, Hollister, Calif.

For more data circle 40 on page 48.

Counters

A new line of highly accurate automatic counting devices for any operation controlled by pneumatic or hydraulic action has been announced by Pneumaticount, 3400 N.E. 54th Avenue, Portland, Oregon. The new counters screw into the line controlling any air or hydraulic cylinder and can be completely installed in five minutes. The manufacturer claims these advantages: no linkage to assemble or get out of adjustment, no solenoid; no possibility of half or miscounts; it will outwear and out perform mechanical counters, total cost less than the usual installation cost. Models are available for from 1 to 5000 pounds and up to 300 counts per minute. All models are available with five or six digits and knob or key reset.

For more data circle 41 on page 48.

Pneumatic Transducer

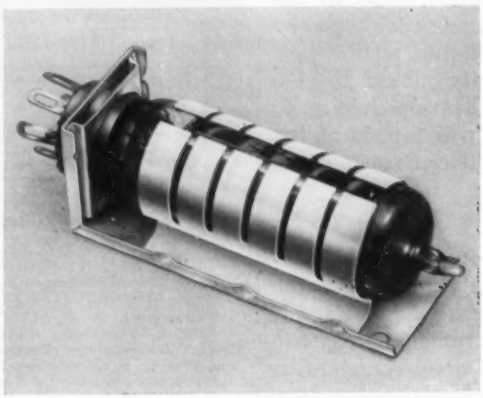
A pneumatic-to-electric transducer the manufacturer believes throws light on the energy-producing and mation-transferring capabilities of pressed air, has been announced by Sheffield Corporation of Dayton, The transducer is a single-switch converts information conveyed by pressed air into electrical signals.

For more data circle 55 on page 48.

Air Wash

A corrosion-resistant entrainment separator for removing moisture from air and other gases is announced by National Carbon Company. The unit employs an impingement type entrainment separator of graphite which mineral acids, organic solvents, and salt solutions, won't corrode. Self-contained and ready for pipe line insertion, the device can be operated at temperatures from —40 to 340°F, pressures from full vacuum to 65 psig. Its construction permits quick disassembly. National Carbon, 100 E. 42 St., New York 17, N.Y.

For more data circle 43 on page 48.



Tube Protector

Featuring a "slotted finger" slee 99½% pure, heat-treated silver these new Kool Klamps offer mum envelope contact and heat ductivity. MIL approved, their kets are mechanically locked in hard-drawn copper base providi rigid mount to withstand sever bration. Industrial Div., The Bir Corp., 4371 Valley Blvd., Los An 32, Calif.

For more data circle 44 on page 48.

Control Wheels

Low-priced control wheels designed for the appliance, power to and electronic industries, are available from stock in sizes from to 1¾" O.D. Trunion pins, hub lengths, hub diameters, hole d ameters, and shapes, can be varied to specifications. The wheels a solid, one-piece units that will not come apart or loosen. Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N.

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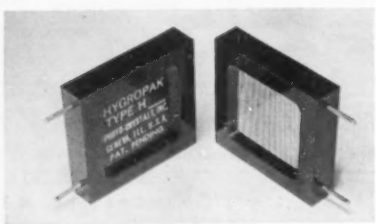
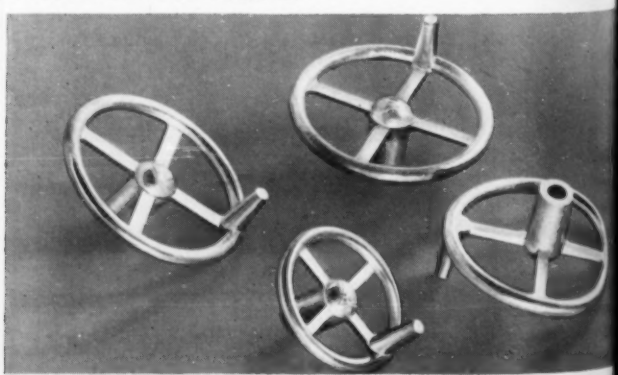
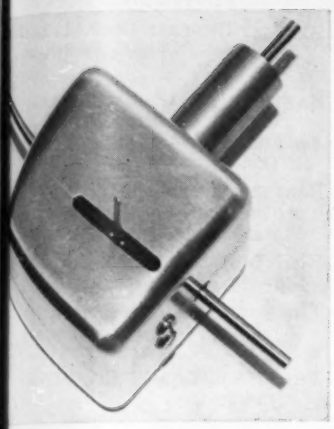


Humidity Measure

Humidity measuring elements capable of operating at temperatures up to 200° F or 600° F, depending on its container, are announced by Photo-Crystals of Geneva, Ill. Applications would be in humidity control and laboratory tests.

For more data circle 45 on page 48.





Mechanical Integrator

A new floating ring integrator, consisting basically of a disc, drum, and ring, has outstanding characteristic of requiring less than .5 grams to position the ring, and thus control the output drum shaft speed relative to the input-disc shaft speed. Negligible force is required to maintain the ring's position at varying speeds and loads. The integrator is suitable for a wide range of applications from chart integrators and servo mechanisms to variable speed drives and linear-to-rotary-motion converters. Optimum Engineering Co., 2017 Willow Street, Grand Prairie, Texas.

For more data circle 54 on page 48.

Glass Joints

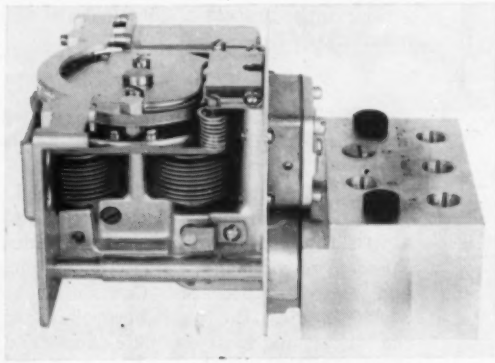
Outer ground glass joints having a constant outside diameter for the entire length of the joint (except for reinforcing bead) has been announced by Kontes Glass of Vineland, N.J. The new design facilitates clamping, imparts greater strength, and eliminates need for a bulb below the ground section: the latter feature eliminates hold-up and thinned-out sections of glass, according to Kontes. Available in a large variety of sizes, a free sample is being offered in response to letter-head requests.

For more data circle 53 on page 48.

iature Motors

iature d-c motors and gen-rs, the dimensions of ch are in fractional inches, which feature self-aigning e bearings with Nylon re-ers that assure quiet run-are available from Heintz ller Engineering Co., 1906 Cicero Ave., Chicago 39, Ill. units, measuring .875" x ", are also available with bearings.

ore data circle 48 on page 48.



Arithmetic Relays

Engineers with problems of ratioing fuel-air flow, determining boiler swell, or totaling flow on multiple lines, will be interested in these universal pneumatic computing relays capable of performing all arithmetical operations. The new series operate on a force-balance principle —four bellows position a floating disc about a fulcrum. The disc acts as does the flapper of a conventional flapper-nozzle detector. Pressure from the bellows sets the position of the disc in relation to the nozzle. Change of pressure in the feedback bellows keeps the disc in balance. Foxboro Co., Foxboro, Mass.

For more data circle 47 on page 48.

Tiny Clutch

Ideally suited as a speed or direction changer in servo-type applications, a new line of miniature electromagnetic clutches is available for electronic and instrument applications. The new MBC line has one input gear hub (A), normally (de-energized) clutched to the output shaft; while the opposite end in put hub (B) is free-turning. When energized, the input hub (B) is clutched to the output shaft and the (A) hub is free-turning. The functions of the shafts may be reversed so that a single input can be connected to either of two output shafts. Additional features: small size, minimum weight, low response time, DC operation. A. J. Thompson, Inc., Route 1, Box 812, Florissant, Mo.

For more data circle 50 on page 48.

Shock-Resistant Meter

A new low-cost panel meter, with a full scale range from zero to 20 microamperes, will withstand punishment more rigorous than the standard military 1200 foot-pound shock test. Lens, flange, and case, are included in a one-piece molding of flexible, shatter-resistant buryrate plastic. Gasker-sealed at the zero adjuster, and treated with anti-static compound, the meter is leakproof and unaffected by static charges. Assembly Products, Chesterland, Ohio.

For more data circle 49 on page 48.

Load-Sensitive Screws

Load-sensitive screws capable of operation at temperatures up to 425°F are now available. The new high-temperature primary-load measuring elements sense tension and compression through a special resistance type strain gage potted axially at the center of the part. Accurate, direct measurement of actual bolt load is possible with standard strain measuring instruments. Polyphase Instrument Co., Bryn Mawr, Pa.

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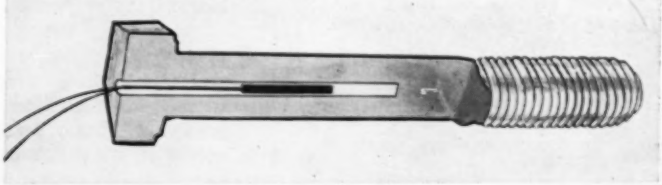


ay: Ceramic Elements

w in production, a positive acting 200 WVDC, non-mag-ic relay, uses two unique electrostrictive ceramic, capaci-units in place of the usual electromagnetic coil to trans-the contacts. The electrostrictive ceramic has the prop-of instantaneously changing its dimensions when sub-ed to an electric field, bending in the same direction for positive and negative polarity. Tests have opened and ed the switches fifty million times with no case of fa-ue or failure. Capaswitch, Mullenbach Div., 2100 E. 27 Los Angeles 58, Calif.

ore data circle 52 on page 48.

Reference Texts

Chemical Process Industries, by R. Norris Shreve, Second Edition, McGraw-Hill Book Company, New York, N.Y., 1004 pp., $11.50.

Wide in scope, this reference to methods used in the manufacture of chemicals and chemical products covers the manufacture of chemicals, description of many manufacturing industries based on important chemical changes (making of plastics, synthetic fibers, ceramics, paints, explosives, and pesticides). The methods are broken down into unit processes and operations by convenient flow sheets, which show the interrelationship of the basic unit processes and the unit operations. Contains important factors, such as data on physical changes and reactions, economics statistics and costs, energy and power required. Basically the book is a chemical engineering approach to the process of chemical and allied industries.

The Condensed Chemical Dictionary, by Arthur and Elizabeth Rose, 5th Edition, Reinhold Publishing Corporation, $12.50, 1200 pp.

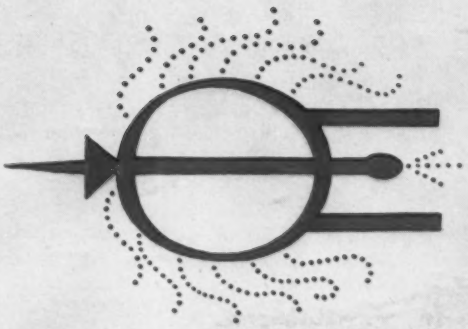
New in format and greatly enlarged in content, this chemical dictionary contains a vast fund of information on chemicals, chemical terminology, trade-name products and related substances. Containing over 30,000 entries, the publishers claim it is the largest and most complete chemical dictionary in both number and kind of entries as well as in extent of essential information authored under each heading. Contains data on the chemical and physical properties of chemicals and raw materials; newest information on containers, shipping regulations and safety instructions; and new uses of chemicals in nuclear energy, chemotherapy and other fields of current interest. Cross references help simplify the confusion often associated with chemicals and their synonyms.

Air Pollution Handbook, edited by Paul L. Magill, F. R. Holden and C. Ackley, McGraw-Hill Book Co., 720pp., illustrated, $15.00.

Written by thirty–one specialists, this book contains highly authoritative discussions on the causes, effects and control of air pollution, including the pertinent facts needed by all types of readers concerned with determining the nature, extent, and effect of air pollution in specific situations and in carrying out abatement programs.

Topics: Control of air pollution at the source; city planning and industrial plant locations; chemistry of contaminated atmospheres; epidemiology of air pollution; effect of air pollution on farm animals and plants; sampling procedures; analytical and experimental test methods; equipment processes for abating air pollution; and a review of basic legal considerations involved in air pollution.

ADVERTISING INDEX



صفة بيضة تخرج وتحرق

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Join two flat pans; fill with an incendiary mixture; add a tail; propel by two large rockets. In A.D. 1280, Arabia's Hassan er-Rammah, gazing centuries ahead, proposed this ovoid in his "The Book of Fighting on Horseback and with War Engines."

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R/D CONTRACTS

Reactors for Venezuela

Venezuela is preparing to launch its first atomic reactor. Dr. Humberto Fernandez Moran, director of Venezuela's nuclear physics research center in Caracas, announces that G. E. will design and build a reactor rated at 3000 kilowatts of heat. The General Nuclear Engineering Corporation of Dundeen, Florida will offer consulting help in setting up the reactor. The Caracas center will use the reactor for research in biophysics, biochemistry, medicine, physics and chemistry. The expected cost: $50 million.

Detergent Plant

Canada's Imperial Oil, Ltd. has asked the Fluor Corporation of Canada, Ltd. to plan and build a detergent alkylate plant at Sarnia, Ontario. It will be the first of its kind in Canada.

Rhenium as a Filament

The Air Force has asked Battelle Institute of Columbus, Ohio to conduct a two year research program leading toward the use of rhenium in electron tubes. Rhenium, a scarce metal with properties similar to those of tungsten and molybdenum, is highly resistant to the water cycle. Also, it is ductile after high temperature cycling, it doesn't form a carbide, and it is less brittle than tungsten. But rhenium is expensive. Present cost is nearly that of platinum. The program hopes to realize the benefits of rhenium while using as little of the expensive metal as possible. Battelle will explore three avenues: coating molybdenum and tungsten with rhenium; developing alloys of the three metals; and coating rhenium filaments with alkaline earth oxides, thorium, and other highly emissive compounds.

Mists, Sprays, and Fumes

Another Battelle contract calls for the study of aerosols for the U. S. Army Chemical Corp., Aerosols are suspensions of solid or liquid particles in air. Battelle will tackle three aspects of the question: sampling procedures, methods of diluting moving aerosol, and changes that occur in moving aerosol streams.

Smog Study

New York University's College of Engineering will attack the aerosol subject from a different angle. It has been commissioned to study the problem of fogged-in or smogged-in airports for the Flight Safety Foundation. The project will assemble chemists, engineers and meteorologists in a concerted effort to improve visibility around airports.

Heavy Water Power Reactor

AEC has commissioned E. I. duPont de Nemours & Co. to determine if heavy water moderated reactors are suitable for generating electricity. The study will center on the use of natural uranium as fuel. duPont will use the laboratory facilities of AEC's Savannah River Plant in Georgia.

Gas-Cooled Nuclear Reactor for Oil Tankers

AEC has awarded General Dynamics Corporation, builder of the Nautilus and Seawolf, a contract to develop a gas cooled nuclear reactor for oil tankers.

HERE'S A BRIEF REVIEW OF LAST MONTH'S PRODUCT ADS IN R/E FOR YOUR INFORMATION.

Precision Engineered Valves 60

Valves especially engineered to provide high pressure control in the atomic sub Nautilus, are similar to types used in high temperature processing.

Autoclave Engineers, Erie, Pa.

Solid State Studies 61

Modern solid state research requires temperatures as low as 0.25°K to reduce the thermal motion of matter sufficiently for study. The two basic tolls which make research at these extreme temperatures practical are the ADL Collins Helium Cryostat and the ADL Magnetic Refrigerator.

Arthur D. Little, Inc., Cambridge, Mass.

Lithium Catalogue 62

A complete compilation of physical and chemical data on lithium compounds is available by writing to:

Foote Mineral Company, 455 Eighteen W. Chelten Building, Philadelphia, Pennsylvania

Checks Jet Engine Performance 63

Two of the most important factors that effect jet engine life, efficiency, and safety are exhaust gas temperature (EGT) and engine speed (RPM). Jetcal analyzer checks these factors with an accuracy of ±0.1%.

B&H Instruments Co., Inc., Fort Worth, Texas

Refractory Strengths 64

Where refractories fail under load and temperature, these refractories have the extra resistance needed to avoid slumping, effect less downtime, lower maintenance costs, and increase output.

The Carborundum Company, Perth Amboy, New Jersey

Interference Microscope 65

An instrument for accurately measuring minute depths of roughness of superfinished surfaces, thickness of coatings, changes of surface structure due to wear, offers magnifications of 80x, 200x, and 480x. It features thalium and white light illuminators.

Carl Zeiss, Inc., New York, N.Y.

New Nylon Lubricant 66

A new development, Nylube, is the first lubricant specifically designed to help nylon do a better job. Its exclusive combinations of lubricating, anti-corrosion, and anti-oxidizing agents seals nylon parts against contamination.

Synco Company, Detroit, Michigan

Electron Microscope 67

The RCA electron microscope reveals for the first time the real structure of titanium calcium pigment. This microscope can be used in micrography of metals.

Radio Corporation of America, Camden, N.J.

Sonic and Spectrum Analyzers 68

Instruments designed to provide a complete history of the time occurance of transient waveform components, in addition to frequency and amplitude information.

Panoramic Radio Products, Inc., Mount Vernon, N.Y.